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[*For Contents, See Fourth Page of Cover.*]

ON DRAINING.

By Mr Andrew Dowie, Factor, Blair-Adam, Kinross-shire.

[Premium—The Gold Medal.]

The property to which this report refers* is situated on the eastern slope of a hilly country, the altitude being from 400 to 700 feet above the level of the sea, the climate cold and moist, the soil and subsoil composed chiefly of cold clay and sandy till, mixed with stones, and of a very retentive nature, with patches of moss from 3 to 7 feet deep intervening. At an early period—viz., from thirty to fifty years ago—the late proprietor† expended large sums in making most substantial sunk fences, in cutting deep drains in the hollows and across the declivities of the fields, and in otherwise improving the estate. The drains were cut deep, particularly in the hollows, and filled with stones, and conduited in the bottom; many of them, being still in good order, serving as leaders for the thorough drains; and the sunk fences, also, are in general 6 feet deep, serving as excellent outfalls.

On the introduction of the Deanston system of draining, the proprietor was amongst the first in adopting it, and a considerable extent of drains was put in, at first filled with broken stones, and afterwards with horse-shoe drain-tile and wooden soles; but, as was then customary, none were cut deeper than 2½ feet, until within the last three years, when a different, and what I consider a more perfect system of drainage, was adopted; but before entering on the details of the mode followed out, I would first beg leave to offer a few remarks on what I look upon as the very *keystone* of all drainage—viz., Outfalls.

In commencing the drainage of a field, the first and most important step to be taken is to secure, at whatever cost, a proper and sufficient outfall, for on this depends, in a great measure, the success of the subsequent operations. However well parallel drains may be executed, if proper attention be not paid to the formation of the outfall, the probability will be that the money will be expended to little purpose.

It is no uncommon thing to observe an outfall led into a running stream or ditch, on a level with the bottom of it; consequently, during the winter floods, the outfall, as well as the small drains, are often for weeks together under back-water. What then can be expected, but that the drains will soon get choked up, and the water again find its way to the surface?

Attention to outfalls and mouths of leading drains is, in my opinion, far too little attended to, not only in their formation,

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* Blair-Adam, the property of Admiral Sir Charles Adam, Lord Lieutenant of the County of Kinross, and Governor of Greenwich Hospital.

† The late Right Honourable Lord Chief Commissioner Adam.

but afterwards in the total neglect of them, and not unfrequently in their being lost sight of altogether.

In draining a field, no expense ought to be spared in bringing forward a sufficient level, so as at all times to keep the outfall clear of back-water; and I would beg to suggest, that, on an estate where there is a considerable extent of drainage, the outfalls and leading drains ought to be put under the charge of an intelligent workman, who shall be furnished with a book containing a sketch of the outfalls and leading drains in each field, and these he ought to examine and clean out at least twice in the year—viz., in spring and autumn, and oftener when necessary.

With these few preliminary remarks, I shall now proceed to report on the drainage of this estate, carried on under my inspection and personal superintendence, containing the depth and distance of the drains, the expense, the nature of the soil and subsoil, &c., and also a comparison between the different kinds of drain-tiles in use.

The extent of the drainage having been considerable, I propose to select only four fields, as an average of the whole, and report on them separately; viz :—

No. 1	Field	contains	35	acres	imperial.
„ 2	do.	do.	17	do.	do.
„ 3	do.	do.	25	do.	do.
„ 4	do.	do.	20	do.	do.

With the exception of No. 1 field, it is not my intention to enter into a detail of the return on outlay, as I consider that the doing so comes more properly under the subject of the "Improvement of Waste Land." I shall therefore confine myself to the return from No. 1 field, which, as formerly stated, contains 35 statute acres, and is intersected by a small watercourse, with about an equal quantity of ground—viz., 17½ acres on each side of it.

The soil of the whole of No. 1 field consists chiefly of a few inches of black or peaty earth, the subsoil a close retentive cold clay or till, and previous to draining produced rushes and other coarse grasses.

This field was drained during the winter and spring of 1848, but as the opposite sides of the field were differently drained, both as to depth of drains and distance between them, and have also been under different modes of management since, I therefore propose to report on each side separately, and shall begin with the southern half, bounded on the north by the said watercourse, along the bank of which, and at the distance of 5 yards, a main drain was cut, 3 feet deep, into which the small drains were led. In the bottom of this main drain a sole was laid, and a conduit built, 8 inches wide, by 10 inches high, and filled up with small stones to within 16 inches of the surface. The small drains were cut 2½ feet deep, and 18 feet apart, and laid with

a wooden sole 5 inches broad, and three-eights of an inch in thickness, and a common horse-shoe drain-tile 3 by 2½ inches. The cost of this part of the field was as follows, viz :—

To cutting, laying, and filling in 660 chains of drain 2½ feet deep, at 1s. 8d. per chain,			£55	0 0
To 36,400 drain-tiles, at 26s. 6d. per thousand, carriage included,			48	4 7
To wooden drain-soles, at 20s. per acre,			17	10 0
Cost of draining south half of No. 1 field,			£120	14 7
Being at the rate of, per acre,			£6	17 11½

Crop 1848.

The field having been in oats the previous year, a second crop was taken after being drained, the ploughing and harrowing of which cost per acre,			0	10 0
Seed oats per acre,			0	12 6
Yearly rent per acre previous to improvement,			0	10 0
			£8	10 5½
Deduct produce of crop, being 4 quarters per acre, at 16s. per quarter,			3	4 0
Balance against improvement at Martinmas 1848,			£5	6 5½

N.B.—Straw allowed for cutting and thrashing.

Crop 1849.

The field in summer fallow, cost of ploughing and harrowing per acre,			1	10 0
To 15 tons of manure per acre, at 4s. per ton,			3	0 0
To 100 bushels lime, at 6d. per bushel,			2	10 0
To grass seeds per acre, sown without a crop at Lammas 1849,			0	12 0
To yearly rent per acre previous to improvement,			0	10 0
Balance against improvement at Martinmas 1849,			£13	8 5½

Crop 1850.

In hay, produce 2½ tons per acre, at £3, 10s. per ton,	£8 15 0			
Foggage, per acre,	0 5 0			
			£9	0 0
			£4	8 5½
To this balance falls to be added, for making hay per acre,			0	6 6
Yearly rent per acre previous to improvement,			0	10 0
Balance against improvement at Martinmas 1850,			£5	4 11½

Crop 1851.

To this balance falls to be added, rent per acre previous to improvement,			£0	10 0
			5	14 11½
The field was sold by auction, for a second crop of hay, at, per acre,	£5 15 1			
Foggage, per acre,	0 5 0			
			£6	0 1
Balance in favour of improvement at Martinmas 1851,			£0	5 1½

The northern half of this field, as formerly stated, has been under different management in every respect. It is bounded on the south by the small water-course formerly alluded to, along

the northern bank of which, and 5 yards distant from it, the main drain was cut, 4 feet deep, and filled with stones, in the same manner as the one on the opposite bank, the small drains being led into it, which were cut 3½ feet deep, and 30 feet apart, laid also with a wooden sole and horse-shoe drain-tile. The cost of draining this portion of the field was as follows, viz.:—

To cutting, laying, and filling in 360 chains of drain 3½ feet deep, at 3s. per chain,	£54	0	0
To 21,600 drain-tiles, at 26s. 6d. per thousand, carriage included,	28	12	5
To wooden drain-soles, 20s. per acre,	17	10	0
Cost of draining north half of No. 1 field,	£100	2	5
Being at the rate of, per acre,	£5	14	5
Crop 1848.			
Add yearly rent per acre previous to improvement,	0	10	0
To 100 bushels of lime per acre, at 6d. per bushel, carriage included,	2	10	0
	£8	14	5
Deduct rent of field let for mowing crop 1848, at the yearly rent of £2, 13s. per acre,	2	13	0
Balance against improvement at Martinmas 1848,	£6	1	5
Crop 1849.			
Add yearly rent per acre previous to improvement,	0	10	0
	£6	11	5
Deduct yearly rent of field in hay,	2	13	0
Balance against improvement at Martinmas 1849,	£3	18	5
Crop 1850.			
Add yearly rent per acre previous to improvement,	0	10	0
	£4	8	5
Deduct yearly rent in hay,	2	13	0
Balance against improvement at Martinmas 1850,	£1	15	5
Crop 1851.			
Add yearly rent per acre previous to improvement,	0	10	0
	£2	5	5
Deduct yearly rent in hay,	2	13	0
Balance in favour of improvement at Martinmas 1851,	£0	7	7

I have thus shown that both portions of the field have, at the end of four years, fully repaid the whole of the outlay on the improvements, and, when let in pasture, will bring on an average 15s. yearly per acre of more rent than what it brought formerly.

In regard to the drainage of this field, it will be observed that the south division cost £20, 12s. 2d. more than the north. This sum might not only have been saved, but also a much more effectual drainage obtained, had the same plan been followed as was done in the north division.

In cutting the drains in the north part of the field, a thin bed

of gravel was gone through, at the depth of 3 feet from the surface, which completely secured the efficiency of the drainage; and had we stopped short at 2½ feet deep, the advantage of this gravel-bed would have been lost, and thereby a greater expenditure incurred, as well as a much less efficient drainage. The south part of the field, although the drains are only 18 feet apart, yet, from being only 2½ feet deep, the ground in rainy weather is much sooner wet, and longer in drying, than the north portion of the field, where the drains are 30 feet apart, but are 3½ feet deep. This, therefore, is a clear proof that deep drains, and widely separated, are not only cheaper, but much more efficient than shallow drains, however close together.

The horse-shoe drain-tile and wooden sole, with which the whole of No. 1 field is drained, have now stood the test of four years, and continue to run as well as when they were first put in; nor, except in one instance, has it ever been necessary to lift a single yard of drain, the exception being the giving way of a single drain-tile.

No. 2 field contains 17 statute acres, and has been in pasture for the last thirty years, and being of a retentive subsoil, it was very much overrun with rushes—so much so, that it was necessary to mow them every year, for the purpose of keeping them down. As the field is situated not far from the mansion-house, it was resolved to drain it effectually. The soil, as formerly stated, was very close and retentive, being a brown loam, the subsoil cold till, intermixed with stones.

The drainage of this field was begun in the end of 1848, and finished in spring 1849. The drains were cut 3½ feet deep, and 15 feet apart; and as the field was to be retained in pasture, the upper sod was kept entire, and laid aside, and, on filling in the drain, was replaced with the green side uppermost.

Two kinds of drain-tile were used in draining this field, the one the common horse-shoe tile, with a clay or tile sole, the other a 2-inch tubular pipe, with a flat side or sole—the former laid with the two ends of the drain-tile meeting on the middle of the sole, the latter laid end to end, without anything to connect them. The cost of the whole was as follows, viz.:—

To cutting, laying, and filling in 728 chains of drain 3½ feet deep, at 2s. per chain,	£72	16	0
To 21,000 open drain-tiles, with tile soles, at £1, 13s. per thousand, carriage included,	34	13	0
To 21,000 2-inch tubular pipe, with flat side, at 27s. 6d. per thousand, carriage included,	28	17	0
	£136	6	6

Being at the rate of £8, 0s. 4½d. per acre.

No main drains were required for this field, as the old drains,

formerly alluded to, were found to be in excellent order, and served as outlets.

Although I cannot give a correct report of the return on the outlay, yet, from the superior quality of the grass now produced, and from the extra quantity of stock kept, I can confidently state that the return is not less than from 13 to 15 per cent. The rushes are fast disappearing, and white clover and other grasses of fine quality are taking their place; and when once a top-dressing is applied, the pasture will be still further improved.

So far as I am able to judge, I consider this field to be well drained, although, in my opinion, had the drains been cut 4 feet deep, and 21 feet apart, the cost would not have been greater, and the drainage more effectual. In a subsoil of clay or till mixed with stones, such as this field is composed of, I find from observation that the deep drain draws better than the shallow one, in consequence of veins of sand being more frequently to be met with nearer the bottom than the surface.

With regard to the kinds of drain-tiles used in draining this field—viz., the common horse-shoe tile, with a tile sole, and the tubular pipe laid end to end—I am inclined to give the preference to the former. In no case has it been found necessary to lift any portion of drain laid with common tile and sole; but where the tubular pipe has been used, it has frequently been necessary, from the bursting of a drain, to examine what was wrong, when it was invariably found that the one end of a pipe had sunk or slipped past its neighbour. I am therefore decidedly of opinion that no pipe drain-tile, whether round or with a flat side or sole, ought to be laid without a collar; but on this I will enter more fully in a subsequent part of my report.

No. 3 field contains 25 acres, and has been under white crop for the last two years, having been trenched and drained during the winter of 1849 and spring of 1850. It is, however, my intention to confine myself to the drainage, and the effects of it on this field, simply remarking that the returns from both crops were quite satisfactory, yielding a clear return of upwards of 18 per cent on the outlay.

The soil of the greater part of this field, with the exception of 3 acres of moss, is a brown loam, the subsoil cold retentive clay mixed with stones, the whole being very wet and swampy, and nearly impassable at all seasons of the year, the pasture coarse and scanty, and the annual rent about 10s. per acre.

A hollow runs from east to west through the centre of the field, the land rising both to the north and south sides of the hollow. After securing a sufficient outfall by cutting a new water-course at the bottom of the field, a main drain was carried along the said hollow, cut 5, and in some places 6 feet deep, the bottom of the drain being mostly on the solid rock. Indeed, in some places the rock had to be cut out, so as to insure sufficient depth. This

main or leading drain was filled with stones. First a strong conduit was built, 12 inches wide and 16 inches high, and then filled with stones to within 16 inches of the top. Into this main drain the whole drainage of the field was led, emptying at one mouth, which in wet weather forms no inconsiderable discharge.

The small drains, which are all led into this main drain from north and south, were cut 4 feet deep, with the exception of the 3 acres of moss, in which the drains were cut 5 feet deep, in order to get through the moss. The distance between the drains is 7 yards, or 21 feet. The mossy part of the field was laid with wooden soles, 5 inches broad and three-eighths of an inch thick, and the drain-tile used was the common or horse-shoe tile, 3 by 2½ inches. The remainder of the field was laid with pipes, both round and flat-sided, and 2 inches in diameter, both kinds having collars, the round pipe having a round collar, and the flat-sided pipe a collar of the same shape; and where the bottom of a drain was soft, a wooden sole was also used. This field I consider to be the most perfectly drained of any one on the estate, No. 4 field excepted; and I do not hesitate to affirm that, although 2½ or even 3 feet drains had been put in only 12 feet apart, the land would never have been in the same state.

The reason of this is obvious from the depth of the drains, the last 6 inches being through sand and gravel. The moisture is completely removed, and in consequence the lands have acquired a firmness and solidity which never would have been the case had the drains been ebber, and ever so close: the plough now does its work with the greatest ease, the horses moving as steadily as if walking on old infield land, where formerly neither man or beast could approach. The following is the expense of the drainage of this field:—

To cutting, laying, and filling in 787 chains of drain, 4 feet deep, at 2s. per chain,	£78	14	0
To 5350 common drain-tiles, at 22s. per thousand,	5	17	8
Drain-soles for do., (wood,)	3	0	0
To 20,000 flat-sided 2-inch pipe-tiles, with collars, at 30s. per thousand,	30	0	0
To 20,000 round 2-inch pipe-tiles, with collars, at 28s. per thousand,	28	0	0
	£145	11	8

Being at the rate of £5, 16s. 5½d. per acre.

No. 4 field contains 20 acres, and in point of soil and subsoil is very similar to the former field, about 8 acres being moss, the soil of the remainder being a brown loam, the subsoil clay and till full of stones, the mossy part producing bent, ling, and other coarse grasses, the hard land being covered with rushes, and the annual rent 10s. per acre.

The whole field was drained and trenched during the winter of 1850, and spring 1851, and sown with oats, with 2 cwt. of guano per

acre applied. The crop turned out well; and although I cannot state the return positively, yet I am confident that it is not under 50 bushels per acre.

The drains on the mossy part of the field were cut 5 and 6 feet deep, and 21 feet apart, quite through the moss, into a bottom of sandy till, and laid with wooden soles and common drain-tiles; those on the hard land cut 4 feet deep, and 21 feet apart. The main drains were cut 6 feet deep, and in the moss were laid with a wooden sole 12 inches wide and three-fourths of an inch thick, and main-drain tiles 10 by 8 inches; the main drains through the hard land were filled with stones, in the same manner as No. 3 field. The small drains were laid with 1½-inch and 2-inch round pipe, and also 2-inch pipe, with flat side or sole, the whole with collars.

Although it is not customary to use collars with flat-sided pipes, the flat side being meant as a substitute for a sole, yet, having frequently experienced the disadvantage attending the laying of pipes end to end, without anything to connect them, I ordered collars to be made with flat sides, to suit the flat-sided pipe, and used in order to prevent the accidental stoppage of the drains by the pipes slipping past each other. The following is the cost of the drainage of this field, viz. :—

To cutting, laying, and filling in 650 chains of drain, 4 feet deep, at 1s. 9d. per chain, ...	£56	17	6
To 14,300 common drain-tiles, at 22s. per thousand, .	15	14	7
To Drain soles for ditto, (wood,)	8	0	0
To 10,000 flat-sided 2-inch pipe, with collars, at 28s. per thousand, ...	14	0	0
To 7000 round 2-inch pipe-tile, with collars, at 26s. per thousand, ...	9	2	0
To 4500 round 1½-inch pipe, with collars, at 24s. per thousand, ...	5	8	0
	£109	2	1

Being at the rate of £5, 9s. 1d. per acre.

I have only further to observe, that the drainage of this field was in every respect as complete as that of No. 3 field. Not a drop of water is to be seen on it; and at present the horses and carts are going over it, removing the crop, where formerly it was impossible to cross at any season. In the several accounts for cutting, laying, and filling in the small drains, the cost of the main drains is included, and also that the length of the horse-shoe and pipe drain-tiles was 14 inches.

I have selected and reported on four fields on this estate, as I consider that they represent the average of the drainage—the drains varying from 2½ to 4 feet in depth, and from 15 to 30 feet apart. A very considerable extent of drains has also been put in by the tenant-farmers on the estate, from 3 to 4 feet deep, and from 15 to 24 feet apart—the tenants paying a per-centage on the outlay, and performing the carriages at their own cost.

It now only remains for me to submit the conclusions I have arrived at, so far as practical experience guides me, in regard to what I consider the proper depth which drains ought to be cut, as well as the distance between each; and also what I consider the best kind of drain-tile, keeping in view the expense, as well as the efficiency, of the kind most proper to be used.

It would now be a waste of words to discuss the question of shallow and deep draining, which I regard as having been already satisfactorily solved. The results on No. 1 field are a clear proof that drains cut 2½ feet deep are a waste of money, not serving the purpose intended; for, had the south half of this field been drained in the same manner as the north half, not only would the sum of £20, 12s. 2d. have been saved, but the field would have been much more effectively drained.

As formerly stated, the portion of the field with the 2½-feet drains is much sooner wet, and is longer in drying, than the opposite side of the field, where the drains are cut 3½ feet deep and 30 feet apart. Water is never seen on the one side, although the soil has never been broken up; but after a heavy fall of rain, it is no uncommon thing to observe water standing on the other side, although it has been broken up, summer fallowed, and is now after a crop of hay.

Before commencing the drainage of a field, I would recommend the sinking of a number of pits, and thereby ascertain the nature of the subsoil. It will generally be found that, in almost every clay or tilly subsoil, veins of sand and gravel are much more frequently to be found at from 3 to 4 feet than at 2½ feet deep. To this I have paid particular attention, and I have invariably found it to be the case. I have therefore, for the last two years, cut no drain less than 4 feet in depth, and generally 21 feet apart; and on no account would I recommend drains at that depth to be placed more than 30 feet apart, unless in a very open subsoil. No. 3 field is also a proof of the benefit of deep drains. Had the drains in it been cut only 3 feet deep, the drainage in a great measure would have been incomplete, the last foot having secured the drainage, from its being composed chiefly of veins of sand and gravel. I am therefore decidedly of opinion, that drains cut 4 feet deep, and from 21 to 27 feet apart, will never fail in securing a permanent and most effective drainage.

With regard to the main or leading drains on this estate, the greater part of them were cut wide, and from 6 to 12 inches deeper than the longitudinal drains, laid with a wooden sole across, except on rock; substantial built conduits, from 8 to 12 inches wide, and from 12 to 16 inches high, with a cover, and filled with small stones above to within 16 inches of the surface; and in moss, where stones cannot be so well applied, main-drain tiles of a large size were used—being 10 by 8 inches, with a wooden sole, 12 inches broad by 3-4ths of an inch thick.

The following are the kinds and prices of drain-tiles most in use in this district—viz., The open or horse-shoe drain-tile, 3 by $2\frac{1}{2}$ inches, with a clay or tile sole, costs 32s. per thousand. The same kind of drain-tile with a wooden sole, 5 inches broad and 3-8ths of an inch thick, about the same price. The drain-pipe, with a flat side or sole, 2 inches diameter, with a collar, costs 28s. per thousand. The 2-inch round pipe and collar, 26s., and the $1\frac{1}{2}$-inch round pipe, 24s. per thousand. I may also mention, that in 1851 I caused a quantity of socket drain-tiles to be made, the one end of which is formed like the wide end of a trumpet, the other rounded off so as to insert into the wide end; but not as yet having had a trial of them, I cannot say how they will answer. I am rather of opinion that they will not suit the purpose so well as the round pipe and collar; for in the event of one part of the bottom of a drain being softer than another, the weight above may press so as to cause the one end to lose the catch of the other. However, as no collar is required, the cost will be less.

Of the different kinds of drain-tiles in use, I prefer the round 2-inch, and $1\frac{1}{2}$-inch pipe with collar. They are not only cheaper than the other kinds, but they lie more secure, the pressure being equal from one end of a drain to the other. Round pipes with a flat side, I believe, never were intended to be laid with collars; nor did I ever see them used, except on this estate. It was in consequence of observing the ends occasionally slip past each other, that I ordered collars with flat sides to be made to suit them; but they are neither so easily laid, nor do they lie so well, as the round pipe and collar, and are also more expensive. I therefore cannot recommend them. The open horse-shoe drain-tile, with a tile sole, as well as with a wooden sole, in moss, if properly laid, makes an excellent running drain, only inferior to the round pipe with collar, which, so far as I am able to judge, is preferable to any other kind in use.

Main-drain tiles are used of all sizes, both open and round; but for main drains I prefer a well-built stone conduit, except in mossy soil, when I prefer the large open tile and wooden sole.

I now beg to state in a few words the conclusion I have come to, that no drain ought to be cut of less depth than 4 feet, nor wider apart than 30 feet, except where the subsoil is very open; that on most soils, 4 feet deep drains, placed from 21 to 27 feet apart, secure the most perfect drainage; and as regards the expense, drains so put in are as cheap, if not cheaper, than $2\frac{1}{2}$-feet drains placed 15 feet apart, in consequence of the saving on drain-tiles. And further, that the round $1\frac{1}{2}$ and 2 inch pipe, with a collar, are not only the cheapest, but also the best kind of drain-tiles in use.

In connection with the very important subject of drainage, I trust that it will not be considered out of place to take notice of

the very great exertions that have been made in this country, both by landlords and tenants, in removing superabundant moisture from the soil; and especially, during the last few years, a great stimulus has been given to drainage in consequence of the grant by Government for that purpose—a grant which has been of very great benefit to the country in general, and to the proprietors of the soil in particular.

But, irrespective of the Government grant, a landlord cannot expend money in any manner, where remuneration is more certain, than in improving his property by draining; and I cannot too strongly recommend the system adopted on this estate, as well as on many others, viz., for the landlord to advance the money for drainage, the tenant performing the carriages, and paying a per-centage on the outlay. To landlord and tenant, I look upon the benefits arising from the adoption of this plan as mutual; to the landlord, in giving him an interest in seeing the drainage efficiently and permanently, as well as economically performed, and at the same time securing to him a fair return—generally 5 per cent—on his outlay; to the tenant, in husbanding his capital, and placing it in his power to apply it in manuring, liming, and otherwise improving his farm, as well as keeping up a sufficient stock of cattle and sheep.

It is well known to every one connected with the soil that undrained lands can never pay; on which account it often presses heavy on a tenant, when he is obliged to sink his capital in thorough-draining his farm. It therefore need not be wondered at if he does so in the easiest and cheapest manner, to serve his purpose during the currency of his lease, which is all he needs to care for. But in the landlord allowing such a system to be pursued, it is generally found that, on the commencement of a new lease, the same process has to be repeated, and the same expense incurred by a new tenant; whereas, had the landlord advanced the money, and the tenant paid a per-centage on the outlay, their interest in effecting a permanent drainage would have been identical; and, on a renewal of the lease, the landlord, in all probability, might look forward to at least 10 per cent of increase on his former rent. This, to my certain knowledge, is by no means uncommon.

In closing this short, and I fear but imperfect report, I would beg to repeat, that the formation of outfalls ought to be the primary object with every one who undertakes the drainage of land, which, if properly attended to, and with drains cut 4 feet deep, and from 21 to 27 feet apart, cut straight, even in the sides and bottom, and laid with 2-inch pipe-tile and collar, will, I am fully satisfied, secure a complete and effectual drainage. I, of course, do not mean to recommend the practice to be adopted as a uniform rule in every case—very much depending on the nature of the subsoil, in regulating the depth and distance between drains—

but I do not hesitate to affirm that the system of drainage I have recommended will be found applicable to nearly two-thirds of the undrained lands of this country.

On the COMPARATIVE ADVANTAGES of FIXED and PORTABLE STEAM-POWER, as APPLICABLE to the PURPOSES of a FARM.

By Mr James D. Ferguson, Bywell Castle, Newcastle-upon-Tyne, formerly Agricultural Engineer in Glasgow.

[Premium—The Medium Gold Medal.]

The writer, in stating his observations in reference to the comparative advantages of fixed and portable steam-power, as applicable to the purposes of a farm, believes he will best convey his opinion in respect to them by dividing this paper into four sections—viz.:

1. Steam applied to the plough.
2. Fixed steam-power applied to thrashing-machines, turnip and chaff cutters, &c.
3. Portable steam-power applied to do. do.
4. Portable horse-power applied to do. do.

Steam-power applied to the plough is, the writer believes, of very recent origin, and, so far as he is aware, the first attempt on a large scale was made some years ago in Lochar moss, near the town of Dumfries. On that occasion many thousands were witnesses of the exhibition, and the writer happened to be one of the number, whose opinion, like many others, in respect to the utility or general advantage of the steam-plough, was by no means favourable. There was evidence, certainly, of a curious and most ingenious piece of mechanism, not only in the engine and its connections, but in the working of the plough; which, however, went but a short way as compensation for the many defects which appeared in the working of both.

On the whole, it was the general opinion at the time that it did its work very imperfectly; and, in consequence of the many obstructions in the soil which it met with—the iron belt which pulled the plough being continually breaking, as well as other parts of the machinery, and, consequently, much time being lost and expense incurred in making repairs—it is the deliberate opinion of the writer that, except for large level tracts of moss or bog, or for large enclosures on extensive level or carse farms, where there are no obstructions in the soil to hinder the free working of the plough, it cannot be brought into general use for the majority of tenants, especially as the great weight of the engine, as well as its expense, will constantly operate to its disadvantage; for if the engine is

fixed in the middle, or at one end of the field, and the plough or ploughs pulled by flexible iron belts similar to the one exhibited near Dumfries, it (the engine) will necessarily be expensive, as it must of necessity be heavy to resist the lateral pressure; and if the engine is made to travel with or in company of the plough, which may be done on dry ground, two or probably three horse power would be expended in dragging the engine itself. All these would materially operate against its general application. In a district of country, however, where there are large enclosures and extensive carse farms comparatively level, of loamy or clayey soil, and no likelihood of the plough meeting with any formidable obstruction in the subsoil, a steam plough might, the writer is positive, be introduced, and advantageously employed, on the principle of the portable steam engine for thrashing, the proprietor of the engine and plough hiring them out from time to time to parties—he charging a certain amount per day or per acre, according to the quantity ploughed, the tenant affording fuel or not, as the case might be.

He would feel very sorry to discourage any invention, by which the labour of cultivation to the farmer would be cheapened; but as respects the application of steam to the working of the plough, he has, like many others, his doubts of its ever being of general advantage to the majority of tenants.

Steam-power, however, both fixed and portable, is and may further be of the greatest advantage to tenants, in driving thrashing-machines, chaff and turnip cutters, &c.; and first, in respect to *fixed* steam-power, which in the end (compared with a portable engine) is not only for farmers of moderate or large extent the cheapest, but steadiest and best. The writer believes himself to be in a position, if not satisfactorily to prove this, at least to give a very decided opinion in reference to it, more especially as it has been his lot not only to attend to various kinds of thrashing-machines driven by horse-power, as well as by fixed and portable steam-power, from a portable one driven by four horses, up to one of twelve-horse power worked by a high-pressure steam-engine, and not only had to feed these machines, but occasionally to attend in the corn barn, as well as to assist in bottling or taking away the straw. He therefore had the fullest opportunity, from several years' severe practical experience, of observing the advantage and disadvantage of these powers, when applied to thrashing-mills.

There can scarcely be two opinions in respect to fixed steam-power being decidedly the best for all corn farms of moderate extent—of say 100 acres or upwards; and his opinion is founded on the following observations: A high-pressure engine, of four-horse power, which is sufficient for a farm of 100 acres, can now be obtained, with boiler and connections, for £90; and although an engine-house, with a chimney of considerable elevation, is abso-

lutely necessary, yet the expense of all these, when compared with the inconvenience and disadvantage of a portable engine for a farm of the size stated, is actually not worthy of consideration. A fixed engine, under cover, is easily kept and attended to, at the rate of about 6d. per day for oil and grease, &c., and is, of course, perfectly steady in its movements when working; while a portable engine, on the contrary, is often the very reverse, being fixed on four wheels; and this of itself is of much importance to notice, and, at any rate, it is generally more expensive for maintenance in tear and wear, &c., and also for oil and grease, in consequence of its exposure to all weathers, being generally put down at the barn door while working.

It is always a matter of considerable importance to the industrious tenant, that he should have it in his power to turn his servants to some in-door work during stormy weather, when it may be improvident to send men and horses into the fields; but if he has a good thrashing-mill, and a fixed engine to drive it, he can never be at a loss in the winter season. He is then comparatively independent. He can get up his steam by daylight in a winter morning, and by thrashing a whole day at once, (as every good managing tenant should do, to save fuel in raising the steam,) he procures not only abundance of fodder for his stock, (which, if stored carefully, will keep fresh a considerable time,) but a large quantity of grain, which, if need be, he can store past, to meet a rising market.

The tenant, however, depending on a portable engine to drive his thrashing-mill, is often not in such a favourable position as his neighbour, having a fixed one of his own. These, in England, are generally kept by parties in the district, who hire them out to tenants at so much per day, or at the rate of so much per bushel, or other measure, according to the kind of corn or length of straw which is thrashed. The engine is generally of four or six horse-power, and is fixed on a carriage having four broad wheels. When a farmer requires the use of this engine, it is necessary that he give notice to the owner of it a few days before it is wanted, and then send two horses (sometimes three are necessary) to drag it the evening before it is wanted, or early on the morning it is to be at work, in order that there may be sufficient time to get up the steam. It is generally set down at the outside of the barn door, and the thrashing-mill driven by a long belt from the fly-wheel of the engine, put over the pulley or sheave of the drum. It is, however, a complaint almost universally made, that in consequence of the engine being fixed on a wheeled carriage, it works usually in a very unsteady manner; and it is not uncommon that derangement and breakage of the thrashing-mill takes place, as well as sometimes of the engine itself.

There are other serious objections to a portable steam-engine; and, first, the risk of fire by sparks flying about, (which can

scarcely be avoided, although some of them are encased in sheet iron); and this of itself is a great objection to its use. Another and serious complaint is, the great inconvenience a tenant is sometimes put to (especially when markets are looking up) in not getting the engine on the day he wants it; for if only one is kept in the district, (and in some districts two would not pay,) there is often such a demand for it, that four or five, and even sometimes six days' notice, require to be given before the use of it can be obtained; and it not unfrequently happens that, before a tenant can get his corn thrashed and ready for the market, grain has again fallen in price.

This the writer has sometimes noticed, and with regret observed the great hindrance it often was to the industrious tenant making the most of his corn crops when markets were rising, whereas, had he had a fixed engine of his own, as, in the opinion of the writer, every tenant possessing a corn farm of 100 acres and upwards should have, (if water, which is the cheapest of all power, cannot be obtained,) he would always be in a position to catch a favourable market for his grain, and this of itself would go far, even sometimes in one season, to counterbalance the rate of interest on the original price of the engine, and buildings connected with it, even although he should build them himself. The writer remembers at one time of a tenant (he having a farm of considerable extent, but no thrashing-mill) being disappointed in getting a portable horse-power gin and thrashing-machine at the time he required it, (and this, by the by, which is also hired out and conveyed from place to place, is ready for work in one half the time that is required for a steam-engine, considering the time that is necessary to get up the steam,) who set a few men to thrash out his corn by the primitive method of flails, rather than lose the opportunity of exposing his grain for sale at a favourable market.

The usual prices of fixed high-pressure steam-engines are as follows:—

One of four-horse power,		with boiler and connections,		will cost	£90
Do.	six	do.	do.	do.	110
Do.	eight	do.	do.	do.	130
Do.	ten	do.	do.	do.	150
Do.	twelve	do.	do.	do.	170

To build the engine-house chimney 40 feet in height, erect engine and boiler house of bricks, 20 feet in length by 14 in breadth, and set up the engine of any of the above, will be, allowing the materials to be brought or carted say ten miles, and the roof a slated one, about £130

A four-horse power fixed high-pressure steam-engine will thrash and dress with a good mill, in a day of eight hours, with 4 cwt. of the best coals, (or a cwt. for each horse-power,) from 250 to 320 bushels of wheat, if the crop is a good one, and reaped in fair condition.

A six-horse power, do. do., will thrash and dress in the same time, with 6 cwt. of coals, from 290 to 370 bushels of wheat.

An eight-horse power, do. do., will thrash and dress in the same time, with 8 cwt. of coals, from 330 to 420 bushels of wheat.

A ten-horse power, do. do., will thrash and dress in the same time, with 10 cwt. of coals, from 420 to 600 bushels of wheat; and

A twelve-horse power, do. do., will thrash and dress in eight hours, with about 12 cwt. of coals, from 600 to 800 bushels of wheat.

It may not, perhaps, be out of place to detail here the number of hands generally employed at this powerful mill of twelve-horse power when working, which was undoubtedly the best the writer ever saw for farm purposes, although there was nothing peculiar in its construction. The feeding rollers were 6 feet in length, and the shaker, (called a travelling shaker,) which was horizontal, sparred across, and 14 feet in length, had a peculiar tremulous motion given to it by machinery, which, when the straw was thrown on to it by two common revolving rake shakers, made the corn pass through it into the hopper of the fanners below, while the straw was moved along by the power of an endless chain, which revolved round cylinders at each end, and made it drop over the partition wall, 14 feet in height, that separated the corn from the straw barn. It was the lot of the writer often to feed this machine, which always wrought a day at a time, and which was exciting although severe work. The number of people required for the machine while thrashing, and to prepare the corn for the market at the same time, and put it into sacks, which was always done, was as follows—viz.:

One man to attend the engine—two and a half, and sometimes three hours, being generally required in the morning to get up the steam, if the coals were good.

One do. to feed the mill.

Two women to unloose the sheaves; one on each side of the feeder.

One man (sometimes a woman) to cast the stack.

Two lads to cart the corn from the stackyard, if the stack was at a distance. The upper floor of the barn being on a level with the stackyard, in the end of which was a coach-house door, loaded carts were run back to the feeding-board.

One man in the corn barn; generally the steward.

Three women in do. do., a pair of hand-dressing fanners being kept going.

Two men taking away the straw. If bottled, four were required.

Two women building and trampling the straw in the end of straw barn.

The prices of portable steam-engines, with carriages, are as follows—viz.:

A four-horse power portable steam-engine, on a carriage with four broad wheels, will cost £220; and with a thrashing-mill and shaker attached, but without fanners, £55 additional.

A six-horse power do. do. do., £250; and with a thrashing-mill and shaker attached, but without fanners, £63 additional.

The writer has not seen any of greater power than the above, which in England are dragged about the country; but it is not uncommon that a thrashing-mill is conveyed from place to place along with the engine, the whole belonging to one person, who hires them out from time to time. When this is the case, the thrashing-mill, which is also fixed on a carriage, is run back into the barn, which in many parts in England is built of wood, and has generally a large door on each side, and when made steady on the floor, is driven by a long belt from the fly-wheel of the engine, which is planted at the outside of the door. Sometimes the thrashing-mill has a pair of dressing fanners attached, but oftener the corn is only thrashed; and sometimes a farmer has a fixed thrashing-mill of his own so constructed, with, and sometimes without fanners, that the engine which he hires to drive it can be easily attached to the sheave or pulley of the drum, and driven by a belt.

A four-horse power portable engine will thrash in eight hours, with a good mill, from 240 to 300 imperial bushels of wheat, if well got, or nearly as much as a fixed engine; but, generally, the portable machines, as before observed, are not so steady as those fixed, and consequently do not do so much work.

A six-horse power portable engine, with a good mill, will thrash in eight hours from 270 to 350 bushels of wheat, if a good crop, and reaped in fair condition.

The prices paid for the hire of portable steam-power thrashing machines are:—The hire of a four-horse power engine with thrashing-mill, runs generally from 10s. to 20s. per day, if only a few hours of it are required, and according to the state and condition of the crop to be thrashed, and sometimes 1d. per bushel is paid if two days' thrashing are required; but, in the latter case, the owner of the engine and mill, whose duty is generally to attend the engine, affords or supplies a man to feed the mill, and the farmer finds fuel for the engine.

The hire of a six-horse power engine and thrashing-mill runs from 15s. to 25s. per day, or according to the length of time the engine is working; but the price of 1d., and sometimes as high as 1½d. per bushel, is more frequently the arrangement made with the owner of the engine.

The party hiring is generally at the expense of carting the engine and mill to his steading when it is required; and in some districts it is common for the farmer last using them to send them with his horses to the next person hiring.

When the thrashing-mill is a fixture, and belonging to the farmer, as is the case in some places, the hire of an engine is then only required, and in that case the price paid for its use is, of course, proportionally less than when both engine and mill are required.

The prices of portable horse-power thrashing machines are:—A portable horse-power thrashing machine, with gin for two horses, including price of the carriage on which they are conveyed, the mill thrashing the corn merely, will cost £60.

A four-horse do. do. will cost £82.

A six-horse do. do. will cost £95.

A two-horse power machine will thrash in a day of eight hours from 150 to 240 bushels of wheat, according to the condition in which the crop has been reaped.

A four-horse power machine will thrash in the same time from 210 to 300 bushels of wheat, according to the condition in which the crop has been reaped.

A six-horse power machine will thrash in the same time from 260 to 350 bushels of wheat, according to the condition in which the crop has been reaped.

The prices paid for the hire of portable horse-power machines with horse gin are:—The hire of a two-horse power thrashing machine with gin for two horses, (the horses belonging to the party hiring,) runs from 10s. to 15s. per day; but oftener 1d. per bushel is paid for the quantity thrashed, and sometimes more, according to bargain, the owner of the machine feeding it, and the farmer affording a man or boy to drive the horses.

The hire of a four or six horse power machine and gin is proportionally more, and runs generally (but much depends on the state or condition of the corn to be thrashed) from 12s. to 16s. or 18s. per day, or 1d., and even sometimes 1½d., per bushel, the owner invariably feeding the machine, and the farmer supplying the horses and other hands for the work, as well as in conveying the machine and gin to the next person requiring them.

The writer has known in some districts the owner of the gin and thrashing machine keeping two, three, or four horses of his own for conveying it and the gin from place to place, as well as for working it; but when this was the case, the charge was, of course, considerably increased—generally 4s. per day for each horse—in addition to the charge per bushel for what was thrashed, and that over and above feeding the horses, which devolved on the party hiring. This, however, is only in districts where the farmers generally are unwilling to allow their horses to be put into a horse gin for thrashing, which they justly reckon very severe for them; consequently fixed steam-power is now becoming general, especially in good agricultural districts, where coals for fuel can be had at a reasonable rate; for the farmers begin to find, that when an engine is employed for thrashing, chaff and turnip cutting

machines and corn bruisers, &c., can at the same time be driven by it, as well as a pump in a urine tank for irrigation, about which a great deal of late has been said and written.

ON THE GROWTH OF TUSSAC GRASS.

By Mr James Ritchie, C. E., Perth.

[Premium—The Medium Gold Medal.]

Greater diversity of soil is rarely to be found, within an equal area, than that exhibited in some districts of the Hebrides and western coasts of Scotland.

In the island of Lewis the arable lands are partly composed of fertile argillaceous loams and rich clays—one field of which, at the northern extremity of the island, is nearly 600 acres in extent—but are principally of peat earth, and a silicious loam, formed by a combination of peat and the debris of gneiss and porphyritic granite—the mildness and moisture of the climate tending greatly to facilitate the gradual disintegration of those rocks, the prevalence of which forms the chief geological characteristic of the island.

In the Lewis, however, and also throughout the Hebrides generally, and the adjacent coasts of the Mainland, the extent of arable land bears but a minute proportion to the total area. Much of the uncultivated land consists of peat or bog, which cannot profitably be brought into cultivation. But indeed past experience has established the fact, the truth of which the present position and future prospects of agriculturists seem more fully to confirm, that in these localities, to farm profitably, the growth of corn must always be subordinate and auxiliary to the cultivation of forage plants—cereal husbandry being more precarious, and less remunerative, in districts where the moisture of the climate is excessive, and where the autumnal gales are frequently violent and destructive.

It is, therefore, somewhat to be regretted that in many West Highland properties, where land has been extensively reclaimed for tillage, yielding returns so incommensurate with the expenditure, more has not been attempted in improving the herbage of the immense tracts of land unreclaimed and irreclaimable, by encouraging the growth of succulent and nutritious grasses, destroying coarse and noxious plants, or by introducing new grasses found to be valuable in a similar soil and climate.

Of the recently introduced gramineæ, the Tussac grass probably stands first in agricultural importance.

The Tussac grass (*Dactylis cæspitosa*) was introduced to Britain

in 1844. It is a hardy perennial forage grass, of the cock's-foot genus and fescue tribe. Referring to this grass in its most luxurious state of growth, as seen in the Falkland Islands, where it abounds, a graphic writer remarks:—"It is called Tussac grass from its roots being so densely matted together as to form a large tuft or *tussac*. These basal or columnar portions, formed by the close approximation of the stems or culms, often rise to a considerable height, from 4 to 6 feet. The long tapering leaves then diverge from them, and hang down all around, often in a very graceful curve, like the falling waters of a *jet d'eau*. The masses are insulated, generally a few feet apart, and the leaves, meeting above, form a kind of arched roof, beneath which the ground is generally quite bare of vegetation. A *tussac ground* thus forms a complete labyrinth, and a man may walk among its green arcades completely concealed from view."

Tussac grass was first introduced to the Lewis by the proprietor, Sir James Matheson, Bart., M.P., and sown under the direction of his chamberlain, Mr Scobie, in 1845.

In a letter to Sir James, Mr Scobie thus describes the method he adopted:—"The seeds which you sent me in 1844 were sown in the following spring in various parts of the island—viz., Coll, Holm, Linshaddir, Galson, &c. Of all these the two former were the only places where this valuable grass appeared; and of these two, Holm was the most successful and vigorous, being sown in a square plot of deep brown moss of medium dryness, close to the sea. The moss, scarcely yielding anything previous to its being turned over and enclosed, was delved over, and cut into small pieces with the spade, and the seeds sprinkled in, and roughly covered with a rake, and trampled in at the same time with the feet. The plants appeared during the following summer and harvest."

In the spring of 1847, a small peninsula on the farm of Holm, jutting out into the Minch, and extending in area to about 17 acres, was fenced off for a tussac ground. The soil is an intractable brown fibrous moss, varying from a few inches to 6 feet in depth, and resting on old red sandstone conglomerate.

At the same time, about 4 acres of this ground, comprising both deep and shallow moss, were drained and delved, and planted with tussac. The drains were chiefly of moss-wedge, and acted but indifferently, in consequence probably of defective construction—which, however, was in favour of the tussac, as a damp condition of soil seems best suited to its successful cultivation. The plants were dibbled into the moss in rows 3 feet 9 inches apart, each plant being the same distance apart in the row, or at the rate of about 3110 plants to the acre. After dibbling, a small quantity of guano mixed with earth was put into the hole before the plant, which was then secured in the ground in the usual way.

This field of tussac now presents a most luxuriant and flourish-

ing appearance, especially in the deep moss, and where most exposed to the sea; but where the moss is shallow, and over three rows which were planted without guano, the tufts, though healthy, are comparatively stunted, and have not attained to such exuberance of growth as the plants in the deeper soil, which rise to a height of from 3 to 4½ feet, the leaves measuring from 5 to 7 feet in length, and the rows overhanging and intermingling with each other, and forming a mass of herbage so dense that one can with difficulty force a way through it. The thickly-matted roots of the full-grown plants are from 12 to 18 inches in diameter, and they seldom penetrate deeper into the soil than 6 or 8 inches.

The whole of this field was cut in February 1851, and the grass consumed by cattle, except one small portion which was left uncut. No difference is now perceptible between that which was cut and the part that was left untouched, both being equally flourishing and vigorous, with the exception of some plants whose stems were partially injured by being cropped too closely to the roots. Two plants from the uncut portion were cut in May following, and found to weigh respectively 46 and 36 lb. The plant weighing 36 lb. was not one of the largest; but taking the average weight of each plant in the deep moss, where the growth is most luxuriant, at 30 lb., we have 3110 plants at 30 lb. each, which gives 41 tons as the aggregate weight per acre. The average weight per acre of the whole field, as nearly as can be ascertained, is 26 tons.

During the winter of 1849–50, the trenching of four additional acres of the same enclosure was commenced, part of which was planted in the manner already described in March 1850, while the moss was yet soft and fresh from the spade—a condition of soil which proved highly favourable, as, in the process of dibbling and planting, the trenched ground was broken and consolidated by the trampling of the people employed in the work, so that it remained unaffected by the dry and parching weather that set in immediately afterwards, and continued until the remainder of the space was trenched and planted in May following, by which time the last trenched moss had become hard and peaty, and more open and porous than is at all desirable for tussac cultivation. Both the early and late planted grass are healthy and thriving; but the part first planted would now afford five times the weight of fodder that could be procured from an equal extent of that planted in May, which, moreover, will in all probability be at least a year later in coming to maturity. This land was not drained. The grass was planted in rows 4 feet apart, the same space being left between the plants in the row. The plants were obtained by raising and dividing tufts from the old plantation, each tuft yielding from 40 to 60 good plants.

Tussac grass is eaten with avidity and much apparent relish by cattle. The soil best adapted to its cultivation appears to be a wet black moss; but it grows well in damp peaty soil of any

description. In the Falkland Islands, where it grows spontaneously, it is said to "flourish most vigorously in the rankest peat bog, black or red." The natural place of its growth is within 300 yards of the sea-shore, exposure to the spray and sea breeze appearing to be a condition essential to its prosperity.

As the soil must be damp no drainage is required, except such as may be effected by shallow open drains run into spots where there is danger of water stagnating or lying on the surface. Trenching may likewise be dispensed with. In preparing ground for planting, a turf 18 inches square may be cut for each plant, then inverted in the hole and cut to pieces with the spade, and the grass dibbled in as already described. In planting by this method, two men, working together, will cut the sods deeper than when only one man is employed. Moor land may in this manner be permanently planted out with tussac grass, at a cost of about 18s. per acre, exclusive of guano and fencing. A fence is indispensable, as cattle, when grazing at will, waste and trample the plants, and destroy the roots, by eating them too closely to the ground—preferring the root and lower part of the plant, because of the large proportion of saccharine matter which they contain. In most peaty soils, however, a sunk fence may be formed at little expense.

A part of the tussac ground at Holm was recently planted in this way; and there is every reason to believe that it will succeed as well as where the land has been regularly trenched.

Tussac should always be planted with a small quantity of guano mixed with earth, or some other stimulating manure, to sustain the young plant until its roots strike into the soil; after which, the alkaline substances which it assimilates from the driving spray and sea breeze, seem to be all that is required to bring it to perfection.

The tussac grass is an evergreen, and is uninjured by frost or snow. It bears planting out remarkably well, and is improved by cutting, if not cropped so closely to the root as to injure the stems. It may be cut in the second year, but it does not arrive at maturity until the third year of its growth.

The seed of the Holm tussac plantation was gathered in July 1850, and purchased by the Messrs Lawson of Edinburgh, none of it being sown in the Lewis. The field was again in seed in January 1851; but as it gave no promise of arriving at maturity, the grass was cut down for fodder. During the summer of 1851 no seeds whatever appeared; but immediately after the grass was cut—early in January 1852—it again began partially to "seed." It may be questionable whether it is quite judicious to cut strong grass, such as tussac, in winter, when it is coming to seed. I have seen no account of the season of its seeding in the Falkland Islands.

The economical value of the tussac grass is exhibited by the following analysis, given by Professor Johnston in the Transactions of the Highland Society for 1848:—

Composition of Tussac Grass grown in the Lewis, and collected in 1847.

			Dried at 330°.	
	Lower part.	Upper part.	Lower part.	Upper part.
Protein compounds, . .	2.47	4.79	17.81	19.38
Sugar, gum, and extractive matter, extracted by water, .	3.32	3.64	23.88	8.93
Other nutritious substances, insoluble in water, but extracted by potash, . . .	1.30	3.17	9.20	18.63
Woody fibre, (cellulose, with a little albumen,) . . .	5.68	11.86	40.88	47.94
Saline matter, (ash,) . .	1.14	1.37	8.23	5.12
Water, . . .	86.09	75.27		
	100.	100.	100.	100.

Referring to this analysis the Professor remarks :—" The first and most striking of the results contained in the third and fourth columns is, the large per-centage of protein, or muscle-forming ingredients. *These are as great as in the best samples of wheat, oats, or barley*, and show, therefore, that this grass is of a very nutritious character."

Three analyses of turnips are given by Professor Johnston in the Transactions of 1848, in which the average per-centage of water is 89.24. The per-centage of water in the tussac, as shown by the above analysis, is 86.09 : the tussac grass, therefore, contains less water, and consequently more solid nutritive matter, than the turnip.

Another sample of this grass from the Lewis, when dried at 212°, left of ash 6.29 per cent. The ash, when analysed by Professor Johnston, was found to consist of the following ingredients:—

Chloride of sodium, ...	12.21
Chloride of potassium, ...	36.01
Sulphate of potash, ...	14.34
Carbonate of potash, ...	14.16
Carbonate of lime, ...	4.42
Carbonate of magnesia, ...	0.41
Phosphate of magnesia, with a little phosphate of lime, .	14.74
Phosphate of iron, ...	1.64
Silica, ...	3.09
	101.02

The growth of tussac grass has only been attempted, in the Lewis, near the sea-shore; but, when tried, it is probable that it may be found sufficiently profitable to warrant its cultivation at considerable distances inland. Chloride of sodium, (common salt,) obtained from the spray and sea breezes, being one of the chief constituents of tussac, an occasional top-dressing with salt has been recommended for inland plantations. The peculiar influences of the sea breeze, however, are not so soon exhausted as is commonly imagined. It has been observed that, during a continuance of gales, the leaves of trees and shrubs situated ten and twelve miles inland acquire a taste of salt.

As supplying winter food, and that of the most nutritious description, tussac grass is well worthy of the attention of stock farmers, who possess a soil suited to its growth, and who are now compelled to prosecute a limited, and therefore expensive, and unsatisfactory course of tillage, for the purpose of providing a small quantity of hay and turnip for winter use.

The great desideratum, likewise, in the agricultural economy of the crofters of the West Highlands and Islands, is an adequate supply of winter food for cattle, as the impoverished condition and attenuated appearance exhibited by their stock, when driven to the moors in spring, but too faithfully attest.

In those districts, therefore, the tussac grass must prove a most welcome and valuable addition to the present stock of forage plants; and, though it may be found amply remunerative under the garden culture, which it receives in some localities, its great value and importance is principally in consequence of its susceptibility of being grown to perfection in soils incapable of producing any other kind of herbage, and which, for ordinary agricultural purposes, are comparatively worthless.

ACCOUNT OF THE SHOW OF THE HIGHLAND AND AGRICULTURAL SOCIETY, HELD AT PERTH IN 1852.

THE Show took place on the 3d, 4th, 5th, and 6th of August. Sixteen years had elapsed since the Society last met at Perth, and during such an interval it was reasonable to expect that much progress and improvement had taken place, and would be made apparent by the Exhibition of 1852. It is satisfactory to know that this anticipation was fully realised, whether as respects the quality of the stock, the variety and excellence of the implements, or the general extent of the show, compared with that of 1836.

The show-yard was erected on a portion of the South Inch, comprising about ten acres, which was placed at the disposal of the Society by the Lord Provost and Magistrates of the city. The Directors would avail themselves of this opportunity to express their thanks, not only for this act of liberality, but for the cordial countenance and co-operation extended to the Society throughout by the local authorities. It is further due to the contractor, Mr Falshaw, a member of the Society, to state, that on no former occasion were the works connected with the show-yard executed so entirely to the satisfaction of the Directors.

On Monday the 2d of August, the division of the yard set apart for implements and machinery was opened at an early hour for the reception of the different articles to be exhibited. With few exceptions, they were all placed before two o'clock on Tuesday, the hour fixed for the Judges to commence their duties. The Directors are gratified, therefore, that they have not to repeat the complaint made at Glasgow, of the inconvenience caused by exhibitors

neglecting the regulation as to time. They have further to report that there was no recurrence, to any extent, of the practice, so much condemned at Glasgow, of withholding implements which had been entered for exhibition, and inserted in the printed catalogue. With few, and perhaps unavoidable, exceptions all the articles entered for the Perth Show were duly forwarded.

On the afternoon of Tuesday, the ploughs, harrows, grubbers, rollers, &c., to be worked, were selected and transferred to the farm of Muirton, where the trial took place on the following morning, under the superintendence of Messrs Gibson, Woolmet; Harrop, Cairnies; and Steedman, Boghall; and in the presence of a large assemblage of agriculturists. The use of the ground was liberally allowed by Mr Morton, the tenant, who further provided the means not only of working the implements, but of conveying them to and from the field. It is due to Mr Morton to state, that he declined to accept any remuneration, either for his own trouble, or for the employment of his horses.

On Wednesday forenoon the yard was opened to the public for the inspection of the implements and dairy produce. In the afternoon an aggregate meeting was held of the Directors, and the Committees for the city and the counties of Perth, Fife, Kinross, Clackmannan, and West Forfar. His Grace the Duke of Athole, as chairman of the General Committee, presided; and arrangements were made to expedite the business of the following day, as explained by the Secretary. In the evening an address was delivered by the Society's chemist, Dr Anderson—his Grace the Duke of Roxburghe in the chair.

On Thursday morning the gates were opened for stock before five o'clock, when a numerous committee, under the charge of the Duke of Athole, so efficiently discharged the very onerous duty of arranging the animals in their respective pens, that above 1300 head were placed by seven o'clock, when the show-yard was cleared, and the Judges were allowed to proceed. Complaints are occasionally made of the regulation which requires the yard to be cleared; but the Directors are convinced of its propriety. It has now been in operation at three successive Shows; and there have been ample means of testing its utility, in enabling the Judges to discharge their duties without interruption, and free from the interference or remark of spectators. It need scarcely be remarked, that such a rule, while in existence, must be stringently enforced without regard to persons.

The doors were opened at ten o'clock, and, though the pressure was great—more particularly at twelve, when the charge was reduced to 1s.—the public were admitted without inconvenience or confusion. This important part of the arrangements was materially aided by the High Constables of Perth, for whose co-operation in superintending the gates and drawing the entrance-money the Directors felt very much indebted.

The banquet was held in the City Hall, which was granted by the Magistrates, and which is admirably adapted for such a purpose. The Duke of Roxburghe, as President of the Society, presided; and the Duke of Athole, as chairman of the local committee, officiated as croupier.

On Friday the usual exhibition of the prize stock and the auction were held; and the whole proceedings of the Show terminated with a trial of reaping machines. This took place on the farm of Muirton, where every assistance and facility were again given by Mr Morton, without putting the Society to any expense. The report of this trial will be found immediately following the details of the Show. It may be proper here to advert to a misunderstanding, and consequent disappointment to some, in reference to the trial of the reaping machines. Many persons attended at Muirton on Wednesday, under the idea that the reapers were to be worked that morning with the other implements; and their absence created an impression that the original arrangement had been departed from, and the trial postponed. For this, however, there was no ground. When the premiums were offered, no trial at Perth was contemplated; and the advertisement, which appeared repeatedly, contained the following note in reference to reaping machines:—"The award will not be made at the Show, as it will necessarily depend on the results of a trial which cannot take place till harvest; but parties intending to compete must exhibit their reaping machines at Perth, when the terms and conditions of the subsequent trial will be communicated." There could therefore have been no just cause of complaint, even had the trial been held in another place, and at a later period; but the Secretary, on his arrival at Perth on the 2d, finding the crops so far advanced, and that Mr Morton was willing to allow his to be cut on the 6th, anticipated the consent of the Directors, and, with the view of gratifying the public, made arrangements for a trial on that day, which was more than had been promised in the programme of the Show.

The Exhibition consisted of the following entries in the different classes of stock:—

CATTLE.

	Bulls.	Cows.	Heifers.	Oxen.	Total.
Short-horns,	47	15	20	...	83
Extra,	...	...	1	...	
Polled,	24	12	16	2	57
Extra,	...	1	1	1	
Ayrshire,	14	22	17	...	55
Extra,	...	...	2	...	
Highland,	18	13	21	12	82
Extra,	...	1	6	11	
Fifeshire,	5	5	4	...	14
	108	69	88	26	291

	Bulls.	Cows.	Heifers.	Oxen.	Total.
	108	69	88	26	291
Extra,					
Alderney,	1	...	...	...	1
Tuscany,	...	1	...	...	1
Orkney,	...	1	...	...	1
Crosses,	...	2	6	10	18
	109	73	94	36	312

HORSES.

	Stallions.	Entire Colts.	Mares.	Fillies.	Highland Pony Stallions or Mares.	Geldings.	Total.
Draught,	21	41	20	34	...	...	135
Extra,	2	...	...	3	9	5	
	23	41	20	37	9	5	

SHEEP.

	Tups.	Ewes.	Gimmers.	Lambs.	Wethers.	Total.
Leicester,	96	80	80	...	...	272
Extra,	5	2	2	7	...	
Cheviot,	71	15	40	...	...	126
Extra,	...	...	...	...	...	
Blackfaced,	33	25	50	...	...	124
Extra,	2	...	...	...	14	
Southdown,	30	50	35	...	...	120
Extra,	...	...	...	5	...	
Extra—						
Dorset,	...	5	...	...	...	5
Romney Marsh,	...	5	5	...	5	15
	237	182	212	12	19	662

SWINE.

	Boars.	Sows.	Pigs.	Total.
Large,	3	4	12	50
Small,	11	20		
	14	24	12	50

POULTRY.

Turkeys, Norfolk or Black Breed,	16
Other Breeds,	10
Capon Turkeys,	...
Fowls, Dorking Breed,	34
... Polish Breed,	2
... Spanish Breed,	10
... Hamburgh Breed,	8
... Old Scotch Breed,	6
... Malay Breed,	8
... Cochin China Breed,	20
... Other Breeds,	14
Capons,	...
Poulards,	2
Ducks, Aylesbury Breed,	18
... Other Breeds,	16
Geese,	22
Total,	186

DAIRY PRODUCE.

	Cured.	Powdered.	Fresh.	Totals.
Butter,	30	21	28	79
	Sweet milk.	Skimmed milk.	Imitation English.	
Cheese,	18	17	9	44
				— 123

IMPLEMENTS.

Ploughs of all kinds,	26	Brought forward,	153
Grubbers,	21	Hay-rakes and tedding machines,	6
Harrows,	13	Thrashing machines,	6
Rollers,	17	Dressing fanners,	4
Swing-trees,	4	Weighing machines,	2
Sowing machines,	18	Churns,	15
Horse-hoes,	3	Cheese-presses,	6
Liquid-manure machines,	2	Curd-cutters,	2
Straw-cutters,	6	Field-gates,	7
Turnip-cutters,	8	Travis divisions, rack and manger,	1
Bruisers,	7	Farm-harness,	4
Root-washers,	4	Drain tiles, pipes, and tools,	9
Steaming apparatus,	2	Flax machinery,	2
Troughs for feeding-byres,	2	Reaping machines,	6
Farm-carts,	9		— 223
Stack-pillars,	11		
Carry forward,	153		
Extra entries,			40

General Collections.

Lord Kinnaird, Rossie Priory,	20
James Slight, Edinburgh,	16
William Cadell, Sons, & Co., Cramond,	1
Grangemouth Coal Co.,	2
Richard Hodgson of Carham,	1
John Wauchope of Edmonstone,	1
Thomas Gorrie, Perth,	6
Charles D. Young & Co., Edinburgh,	9
Young, Peddie, & Co., Edinburgh,	20
	— 76
Total,	339

ABSTRACT.

Cattle.	Horses.	Sheep.	Swine.	Poultry.	Dairy produce.	Implements.
312	135	662	50	186	123	339

Total head of Animals,	1345
Total number of Articles,	462

The following statement gives a comparative view of the Exhibition at Perth in 1836 and in 1852.

Cattle.	Perth. 1836.	Perth. 1852.
Short-horns,	45	82
Angus, Aberdeen, and Galloway Polled,	14	54
Ayrshire,	33	53
West Highland,	65	64
Fife,	20	14
Extra,	88	45
	— 265	— 312
Horses,	46	135
	311	447

Sheep.	Perth. 1836.		Perth. 1852.	
Brought up,	311		447	
Leicester,	192		256	
Cheviot,	16		126	
Black-faced,	133		108	
Southdown,	...		115	
Extra,	75		57	
		727		1109
Swine,		18		50
Poultry,		...		186
Dairy Produce,		6		123
Implements,		17		339
		768		1807

PREMIUMS AWARDED.

CATTLE.

SHORT HORNS.

Judges.—Randle W. Saunders of Nunwick Hall, Penrith; Hugh Watson, Keillor, Forfarshire; and John Wilson, Edington Mains, Berwickshire. —*Attending Member*, His Grace the Duke of Roxburghe.

Sweepstakes for Short-horn Bulls—to Thomas Chrisp, Hawkhill, Alnwick.

For the best Bull of any age—twenty sovereigns, to Thomas Chrisp, Hawkhill, Alnwick.

The silver medal to Thomas Chrisp, as the *Breeder* of the best Bull.

For the best Bull, calved after 1st January 1850—ten sovereigns, to A. Cruickshank, Sittyton, Aberdeen.

For the best Bull, calved after 1st January 1851—six sovereigns, to His Grace the Duke of Buccleuch, Dalkeith Park.

For the best Cow of any age—ten sovereigns, to James Douglas, Athelstaneford, Haddington.

For the second best—five sovereigns, to William Tod, Elphinstone Tower, Tranent.

For the best Heifer, calved after 1st January 1850—eight sovereigns, to James Douglas, Athelstaneford, Haddington.

For the second best—four sovereigns, to James C. Grant Duff of Eden, Banff.

For the best Heifer, calved after the 1st January 1851—five sovereigns, to James Douglas, Athelstaneford, Haddington.

In the opinion of the Judges, the aged bulls were very superior to the younger. The former, on the whole, were good and useful animals, and some of them indicated marked merit. The young bulls, on the other hand, with the exception of the prize-takers and two or three more, were not exactly of that stamp which might have been looked for on such an occasion, or which could be with confidence expected to form the sires of superior stock. As a similar deficiency was observed at Glasgow in 1850, and as the improvement of the domesticated animals can only be successfully accomplished by the persevering use of males of better breeding than the females with which they are coupled, the Directors would impress on the attention of breeders the paramount importance of securing young bulls of the purest descent, and in the highest points of quality. If this rule be not rigidly adhered to, short-horns, while they increase in numbers, must inevitably retrograde in quality. It is

satisfactory to report that, in the female class of this breed, the younger surpassed the older animals, and that they were not only deserving of commendation as a lot, but presented excellent specimens of individual merit.

Notwithstanding the discouragement shown by the Society to over-feeding, the Directors regretted to observe the excessive state of fatness in which some of the animals were exhibited. The Society's Judges are specially instructed to withhold premiums from all over-fed bulls, cows, and heifers; and if it should appear that this intimation is insufficient to deter exhibitors from sending such animals in an unfit and improper state, other and more stringent means must be adopted to mark the opinion of the Society, by preventing their admission to its Shows.

POLLED CATTLE.

Judges.—Arthur Glennie, Fernieflat, Kincardineshire; John Graham, yr. of Shaw, Dumfriesshire; George Milne, Haddo, Aberdeenshire.—*Attending Member*, Robert Stewart of Ardvorlich, Perthshire.

Sweepstakes for Polled Bulls, to Hugh Watson, Keillor, Coupar-Angus.

For the best Bull of any age—fifteen sovereigns, to Hugh Watson, Keillor, Coupar-Angus.

The silver medal—to Hugh Watson, Keillor, as the *breeder* of the best Bull.

For the best Bull, calved after 1st January 1850—eight sovereigns, to Alexander Bowie, Mains of Kelly, Arbroath.

For the best Bull, calved after 1st January 1851—five sovereigns, to Thomas Carnegy of Craigo, Montrose.

For the best Cow of any age—eight sovereigns, to William M'Combie, Tillyfour, Aberdeen.

For the second best—four sovereigns, to Hugh Watson, Keillor, Coupar-Angus.

For the best Heifer, calved after 1st January 1850—six sovereigns, to William M'Combie, Tillyfour, Aberdeen.

For the second best—three sovereigns, to William M'Combie, Tillyfour, Aberdeen.

For the best Heifer, calved after 1st January 1851—four sovereigns, to Robert Scott, Balwyllo, Brechin.

For the best pair of Oxen, calved after 1st January 1849—the medium gold medal, to William M'Combie, Tillyfour, Aberdeen.

For some years back the Angus and Aberdeen polled and the Galloway polled have been separately judged at the Society's Shows. On this occasion, however, the original practice of classing them together was reverted to. In doing so, the Directors conceived that it might be useful to bring these varieties, of what is essentially the same breed, into closer comparison, with the view of determining their respective qualities, and of ascertaining the points in which either is deficient, or where the one may gain by an intermixture with the other. The following observations, taken from the report of the Judge who attended from the Galloway district, induces the Directors to hope that their object has not been overlooked. That gentleman remarks that, as a general rule, Angus and Galloways would be better shown separately;

but he states, "I am rather of opinion it has been wisely judged in having the two breeds classed together at the Show, as it may turn the attention of breeders of Galloways more to the useful qualities of these animals—that is, in being more careful with regard to the softness of touch, which is the requisite for aptitude to fatten, instead of looking so much to the great length of hair, (without reference to its softness,) which, I think, is too much followed in this part of the country, to the exclusion of more useful qualities. I am of opinion that the Galloways may be much improved by judicious crossing with the Angus, though adapted to certain modes of farming for which the pure Angus would be too tender."

There was admittedly no comparison between the Galloways and the Angus or Aberdeens. It is right, however, to remark that, while the former were regarded as below an average of former Shows, the latter were perhaps never before surpassed in quality. In this breed, male and female of all ages exhibited superior merit, and many were splendid examples of individual excellence. The bull belonging to Mr Watson, Keillor, which carried the sweepstakes, was particularly reported by the Judges as an extraordinary animal, and unrivalled for strength, symmetry, and quality, though now fourteen years of age. In fact, he showed the perfection to which judgment and attention can bring this valuable breed. The Directors rejoice that this and preceding Shows indicate a praiseworthy amount of effort and care on the part of breeders of Polled cattle, followed by a corresponding improvement in the stock. They cannot but regard it as perhaps the most valuable breed of Scotland, combining, as it does, in a great measure, the constitution of the Highlander with the feeding properties of the Short-horn. At Perth, as on previous occasions, the Polled cattle formed the principal object of interest and admiration on the part of strangers from England and Ireland.

AYRSHIRE.

Judges.—William Forrest of Treesbank, Lanarkshire; Patrick Graham Barns of Limekilns, Lanarkshire; Arthur Mather, Nether Place, Renfrewshire.—*Attending Member*, His Grace the Duke of Athole.

Sweepstakes for Ayrshire Bulls—to A. W. Buttery, Monkland, Airdrie.

For the best Bull of any age—fifteen sovereigns, to A. W. Buttery, Monkland, Airdrie.

The silver medal—to Mr Calder, Miller's Neuk, Kirkintilloch, as the *breeder* of the best Bull.

For the best Bull, calved after 1st January 1850—eight sovereigns, to A. W. Buttery, Monkland, Airdrie.

For the best Cow of any age, in milk—eight sovereigns, to A. W. Buttery, Monkland, Airdrie.

For the second best—four sovereigns, to James Young, Handaxwood, Whitburn.

For the best Cow of any age, in calf—six sovereigns, to Alexander M'Lachlan, East Long-haugh, Bishopton, Renfrewshire.

For the second best—three sovereigns, to Robert Kirkwood, High Longmuir, Kilmaurs.

For the best Heifer, calved after 1st January 1850—six sovereigns, to John Paterson, Macorriston, Doune.

For the second best—three sovereigns, to William Muir, Haddington Mains, Biggar.

For the best Heifer, calved after 1st January 1851—four sovereigns, to John Hamilton, Burnbrae, Avondale.

From the character of the district more immediately connected with the Show, the exhibition of Ayrshires could not be expected to equal in numbers that at Glasgow in 1850. In point of quality, the bulls were generally superior in symmetry. The cows in calf were good, though somewhat deficient in weight; but those in milk were generally wanting in shape, condition, and weight. With reference to the question of weight, the Directors would reprint, as applicable to the late exhibition, the remarks called forth at Glasgow. "It is to be feared that the Ayrshire milking stock, of late years, has been bred to too light weights—a delicate appearance and a well-set udder being the points most aimed at. These points have been attained by the practice of starving the young heifers, with the supposed object of making them good milking cows; but a good milker, it is apprehended, will not be formed by any such negative means. An improvement, it is believed, would be effected in both points, were the heifers bred so as to attain heavier weights and greater substance; and on becoming cows, they would then not only prove greater milkers, but might easily be fed a hundredweight or two heavier. The paramount object to be held in view, in breeding Ayrshires, is obviously to obtain the largest quantity of good milk, with a tendency to fatten when put up to be fed; and neither of these ends will be attained by light weights and delicacy of appearance."

HIGHLAND.

Judges.—Lorne Campbell, Roseneath, Dumbartonshire; John Macfarlane, Faslane, Dumbartonshire; John S. Menzies of Chesthill, Perthshire.—*Attending Member*, Sir John Muir Mackenzie of Delvin, Bart., Perthshire.

For the best Bull of any age—fifteen sovereigns, to the Right Hon. Duncan M'Neill of Colonsay, Lord Justice General.

The silver medal—to Charles Stewart, late of Chesthill, as the *breeder* of the best Bull.

For the best Bull, calved after 1st January 1850—eight sovereigns, to John Macdonald, Inverlochlang, Lochearnhead.

For the best Cow of any age—eight sovereigns, to the Marquis of Breadalbane, Taymouth Castle.

For the second best—four sovereigns, to Neill Malcolm of Poltalloch, Lochgilphead.

For the best Heifer, calved after 1st January 1849—six sovereigns, to the Marquis of Breadalbane, Taymouth Castle.

For the second best—three sovereigns, to Robert Peter, Urlar, Aberfeldy.

For the best Heifer, calved after 1st January 1850—four sovereigns, to Donald M'Laren, Braeleny, Callander.

For the best pair of Oxen, calved after 1st January 1848—the medium gold medal, to Alexander Campbell of Monzie, Crieff.

EXTRA SECTIONS OF THE HIGHLAND BREED.

Open to tenants paying a rent not exceeding £100 *per annum.*

For the best Bull of any age. *No entry.*
For the best Bull, calved after 1st January 1850. *No entry.*
For the best Cow of any age. *No entry.*
For the best Heifer, calved after 1st January 1849. *No entry.*
For the best Heifer, calved after 1st January 1850. *No entry.*

Considering the proximity of the Show to some of the best breeding districts for Highland cattle, the exhibition in this class did not, in point of extent, realise what was anticipated. With regard to quality, the Judges had cause to repeat the statement which, it may be recollected, was contained in the notice of the Glasgow Show, that the aged bulls were inferior. On this occasion, with certain exceptions, their deficiency in size for breeding purposes was obvious. It is much to be regretted that recent Shows have not exhibited that progress in this interesting and valuable native breed which characterises stock of other descriptions. The younger bulls, cows, and heifers excelled the old bulls, and were equal to what have appeared on former occasions.

FIFESHIRE.

Judges.—J. B. Fernie of Kilmux, Fifeshire; Arthur Glennie, Fernieflat; Kincardineshire; John Graham, yr. of Shaw, Dumfriesshire; James Gulland, Newton of Wemyss, Fifeshire; George Milne, Haddo, Aberdeenshire. —*Attending Member*, Robert Stewart of Ardvorlich, Perthshire.

Sweepstakes for Fifeshire Bulls—to Robert Wilson, Firthfield, Anstruther.

For the best Bull of any age—ten sovereigns, to John Rintoul, Ovenston, Pittenweem.

The silver medal—to John Rintoul, as the *breeder* of the best Bull.

For the best Cow of any age—six sovereigns, to William Fullarton, Mains of Ardestie, Dundee.

For the best Heifer, calved after 1st January 1850—four sovereigns, to David Wallace, Balgrummo, Leven.

NOTE.—The Judges reported that only two animals were exhibited for the sweepstakes.

It is a question with many judges whether the Fifeshire breed exists in a pure state; if so, its numbers are insignificant, and its importance questionable. At no Show has the Society succeeded in bringing together above a few examples of the breed, and the Directors have it consequently in contemplation to discontinue offering premiums for it. The animals exhibited at Perth were not considered worthy of high commendation.

EXTRA CATTLE.

Judges.—James Gulland, Newton of Wemyss; John M'Laren, Millhill, Perthshire; John Smith, Kinblethmont, Forfarshire.—*Attending Member*, James B. Fernie of Kilmux.

The Judges commended the following animals:—

Short-horn Heifer belonging to William Stirling of Keir, Dunblane; Angus polled Cow and Calf belonging to Hugh Watson, Keillor, Coupar-Angus, highly commended; Six Highland Oxen belonging to the Earl of Glasgow; Two Highland Oxen belonging to the Marquis of Breadalbane; Four Highland Heifers belonging to the Marquis of Breadalbane; Highland Heifer belonging to the Hon. Lady Menzies of Menzies; Highland Heifer belonging to James Archibald Campbell of Inverawe; Two Cross Heifers belonging to William Dingwall, Ramornie, Fifeshire; Tuscany Cow belonging to Col. Ferguson of Raith, Kirkcaldy; Cross Heifer and Ox belonging to James L. Miller, Wauk Mill, Dunfermline; Two Cross Oxen belonging to George Brown, South Quarter, Kingsbarns, St Andrews.

In this class, the Cow and Calf of the polled breed, bred and exhibited by Mr Watson, Keillor, excited much interest. The cow is twenty-six years of age, and, having reared twenty-three calves, shows strikingly the sound constitution of the stock, which is now more than ever an important qualification. This cow, having long previously won the Society's highest premiums, was disqualified from competing, and had consequently to be exhibited as extra stock.

HORSES

FOR AGRICULTURAL PURPOSES.

Judges.—Archibald Butter of Faskally, Perthshire; Finlay Dun, V.S., Edinburgh; William Glen, Hawkhead Mains, Renfrewshire; James Steedman, Boghall, Mid-Lothian.—*Attending Member*, Sir P. Murray Thriepland of Fingask, Bart., Perthshire.

For the best Stallion—twenty-five sovereigns, to Samuel Clark, Manswrae, Kilbarchan.

For the second best—ten sovereigns, to John Smith, Grassmarket, Edinburgh.

For the best entire Colt, foaled after 1st January 1849—ten sovereigns, to Alexander Lawson, Old Mills, Elgin.

For the best entire Colt, foaled after 1st January 1850—eight sovereigns, to James Kay, Hillfarm, Gargunnoch, Stirlingshire.

For the best entire Colt, foaled after 1st January 1851—six sovereigns, to John and Peter Young, Niddry, Winchburgh, West Lothian.

For the best Mare—ten sovereigns, to A. W. Buttery, Monkland, Airdrie.

For the second best—five sovereigns, to Andrew Logan, Crossflit, Kilbarchan, Renfrewshire.

For the best Filly, foaled after 1st January 1849—eight sovereigns, to Robert Murdoch, Hallside, Cambuslang.

For the best Filly, foaled after 1st January 1850—six sovereigns, to Andrew Logan, Crossflit, Kilbarchan, Renfrewshire.

For the best Filly, foaled after 1st January 1851—four sovereigns, to Robert Jack, Balcarroch, Campsie, Stirlingshire.

EXTRA SECTIONS.—HIGHLAND PONIES.

Judges.—Archibald Butter of Faskally, Perthshire; John S. Menzies of Chesthill, Perthshire.—*Attending Member*, Archibald Campbell of Glendaruel, Argyllshire.

For the best Highland Pony Stallion, not over 14 nor under 12 hands—eight sovereigns, to Alexander Campbell of Monzie, Crieff.

For the best Highland Pony Mare, of the same height—five sovereigns, to Sir John Stuart Forbes of Pitsligo and Fettercairn, Bart.

EXTRA HORSES.

The Judges commended the following animals:—

Clydesdale Stallion belonging to Robert Arkley, Philipston, Queensferry; Carriage Stallion belonging to Robert Mackay, Dalkeith.

The appearance of the horses was highly creditable. The aged horses were, as usual, the most numerous, and there were amongst them many good specimens of powerful, active, and useful farm horses. The three-year-old colts were, as a class, somewhat inferior, except the first-prize horse, which was equal to anything of its age seen for some years. The two-year-olds were excellent, many of them promising to prove valuable stud horses. The yearlings were creditable, but not so good. The show of mares excelled that of horses; and, though surpassed at Glasgow in numbers, it was perhaps, in point of quality, one of the best ever brought together in Scotland. The mare which gained the first premium at Glasgow in 1850, and which was therefore, by the rules of the Society, disqualified for competition, was exhibited, and deservedly commended. The young mares were highly creditable, and though somewhat inferior to the aged ones, promise, when they reach maturity, to be superior breeding animals.

The Judges concurred in representing the great importance, too often overlooked, of carefully selecting and attending to colts and fillies from the earliest stage, and expressed a hope that the Society will continue to encourage this by giving, if possible, increased premiums for young animals.

SHEEP.

LEICESTERS.

Judges.—John Dudgeon, Spylaw, Roxburghshire; John Dudgeon, Almondhill, West Lothian; Thomas Scott, Beal, Northumberland.—*Attending Member*, Sir David Dundas of Dunira, Bart., Perthshire.

For the best Tup, not exceeding four years old—eight sovereigns, to John Davidson, Brandon Whitehouse, Northumberland.

For the second best—four sovereigns, to Thomas Dickinson, Maiden Hall, St Boswells.

For the best pair of Dinmont or Shearling Tups—eight sovereigns, to John Davidson, Brandon Whitehouse, Northumberland.

For the second best—four sovereigns, to James Douglas, Athelstaneford, Haddington.

For the best Pen of Five Ewes, not exceeding five years old—six sovereigns, to Adam Thomson, Rutherford, Kelso.

For the second best—three sovereigns, to William Tod, Elphinstone Tower, Tranent.

For the best Pen of Five Shearling Ewes or Gimmers—four sovereigns, to James Douglas, Athelstaneford, Haddington.

The Judges considered the quality of this stock to be of a superior description, more particularly in the sections of aged Tups and Gimmers, which possessed merit of a high order. In many instances, the excellence of the competing lots so nearly approximated, that considerable difficulty was experienced in awarding the Premiums.

CHEVIOTS.

Judges.—George Douglas, Plenderleith, Roxburghshire; Andrew Scott, Tarbat House, Ross-shire.—*Attending Member*, Alexander Macduff of Bonhard, Perthshire.

For the best Tup, not exceeding four years old—eight sovereigns, to James Brydon, Moodlaw, Langholm.

For the second best—four sovereigns, to Walter Carruthers, Kirkhill, Moffat.

For the best Pair of Dinmont or Shearling Tups—eight sovereigns, to Thomas Elliot, Hindhope, Jedburgh.

For the second best—four sovereigns, to Thomas Elliot, Hindhope.

For the best Pen of Five Ewes, not exceeding five years old—six sovereigns, to Thomas Elliot, Hindhope.

For the second best—three sovereigns, to James Brydon, Moodlaw, Langholm.

For the best Pen of Five Gimmers, lambed after 1st April 1851—four sovereigns, to Thomas Elliot, Hindhope, Jedburgh.

This stock the Judges reported as being generally of more than ordinary merit, many of the lots presenting examples of first-rate quality.

BLACKFACED.

Judges.—Alexander Denholm, Baitlaws, Lanarkshire; Kenneth Kennedy, Leanachan, Inverness-shire.—*Attending Member*, Alexander Campbell of Monzie, Perthshire.

For the best Tup, not exceeding four years old—eight sovereigns, to Robert Paterson of Birthwood, Biggar.

For the second best—four sovereigns, to Adam Blacklock, Minnygap, Moffat.

For the best Pair of Dinmont or Shearling Tups—eight sovereigns, to James Tweedie, Nether Abington, Lanarkshire.

For the second best—four sovereigns, to John and James Watson, Mitchellhill, Biggar.

For the best Pen of Five Ewes, not exceeding five years old—six sovereigns, to James Brydon, Kinnelhead, Moffat.

For the second best—three sovereigns, to Donald M'Laren, Braeleny, Callander.

For the best Pen of Five Gimmers, lambed after 1st April 1851—four sovereigns, to Patrick Small, Dirnanean, Kirkmichael, Perthshire.

The show of Blackfaced Sheep was considered, on the whole, to be very good, though it embraced some animals scarcely qualified to be presented on such an occasion. It is to be apprehended, not only that too little attention generally is paid to the improvement of Blackfaced Sheep, but that an indiscriminate system of crossing may ere long, in some districts, destroy its purity, if not

imperil its existence. It is earnestly hoped that every effort will be made to maintain the purity and develop the qualities of a breed so peculiarly suitable for many parts of this country.

SOUTHDOWNS.

Judges.—Andrew Bell, Hope House, Alnwick, Northumberland; George Willis, Keithock Mains, Coupar-Angus.—*Attending Member*, James Campbell of Craigie, Ayrshire.

For the best Tup, not exceeding four years old—eight sovereigns, to James Aitchison of Alderston, Haddington.

For the second best—four sovereigns, to Hugh Watson, Keillor, Coupar-Angus.

For the best Pair of Shearling Tups—eight sovereigns, to Hugh Watson, Keillor, Coupar-Angus.

For the second best—four sovereigns, to James Aitchison of Alderston, Haddington.

For the best Pen of Five Ewes, not exceeding five years old—six sovereigns, to Hugh Watson, Keillor, Coupar-Angus.

For the second best—three sovereigns, to William Tod, Elphinstone Tower, Tranent.

For the best Pen of Five Shearling Ewes or Gimmers—four sovereigns, to Hugh Watson, Keillor, Coupar-Angus.

The exhibition of Southdowns, though not equal, perhaps, to what may be seen in some parts of England, was the best the Society has yet had; and even in the opinion of the English Judges, many of the lots were examples of what "prime Downs" should be. At former Shows, this breed was, in some measure, ranked as a supernumerary class, and fewer premiums were given for it than for the others. At Perth, however, it was placed, in this respect, on a par with them, the Directors being anxious to direct attention to the extension of a race so remarkable for its docility, earliness, aptitude to fatten, and power of producing a superior carcase of mutton.

EXTRA SHEEP.

The Judges commended the following animals:—

Five Southdown Lambs, belonging to Robert Scot Skirving, Campton, Haddington.

Five Romney-Marsh Ewes, and Five Romney-Marsh Gimmers, belonging to David Park, Tynefield, Dunbar, commended as a breed likely to be useful in crossing with sheep for high pastures.

Five Romney-Marsh Wethers, belonging to John Brown Wright, Hedderwick Hill, Dunbar.

SWINE.

Judges.—Anthony Cruickshank, Aberdeen; James Gordon of Manar, Aberdeenshire; Claude Scott Steuart of Dalguise, Perthshire.—*Attending Member*, Alexander Duthie, Aberdeen.

For the best Boar, large breed—five sovereigns, to W. H. Brown of Ashley, Ratho, Mid-Lothian.

For the second best—three sovereigns, to John Gordon of Aikenhead, Glasgow.

For the best Boar, small breed—five sovereigns, to Jonathan Brown, The Height, Wigton, Cumberland.

For the second best—three sovereigns, to Robert Harrison Watson, Bolton Park, Wigton, Cumberland.

For the best Sow, large breed—four sovereigns, to George Hay Plummer, Melville, Dalkeith.

For the second best—two sovereigns. No award.

For the best Sow, small breed—four sovereigns, to John Arkley, Powmill, Brechin.

For the second best—two sovereigns, to A. W. Buttery, Monkland, Airdrie.

For the best Pen of Three Pigs, not exceeding eight months old—four sovereigns, to Jonathan Brown, The Height, Wigton, Cumberland.

For the second best—two sovereigns, to the Earl of Mansfield, Scone Palace.

There were some excellent specimens of the small breed, but the show of the large was deficient. This may partly be accounted for by exhibitors improperly entering animals belonging to it for competition with the small class. When this was observed, the lots were of course passed by the Judges; and it is believed that in some instances parties, by unfairly attempting to compete out of their proper class, lost the premiums which might probably have been awarded to them in it. The Judges noticed with commendation that there was less of that extra feeding and excessive fatness which has of late so much prevailed, and which the Society so strongly condemns in all breeding animals.

POULTRY.

Judges.—James Gordon of Manar, Aberdeenshire; Claude Scott Steuart of Dalguise, Perthshire—*Attending Member*, Patrick Keir, yr. of Kinmonth, Perthshire.

For the best pair of Turkeys, Norfolk or Black breed—one sovereign, to James Wilson, Woodburn, Dalkeith.

For the best pair of Turkeys of any other breed—one sovereign, to the Marquis of Breadalbane, Taymouth.

For the best pair of Capon Turkeys. *No entry.*

For the best pair of Fowls, mottled or speckled, Dorking breed—one sovereign, to Robert E. C. Benton, Glasgow.

For the best pair of Fowls, Polish breed. *No award.*

For the best pair of Fowls, Spanish breed—one sovereign, to R. E. C. Benton, Glasgow.

For the best pair of Fowls, gold or silver spangled, Hamburgh breed—one sovereign, to R. E. C. Benton, Glasgow.

For the best pair of Fowls, grey speckled or old Scotch breed. *No award.*

For the best pair of Fowls, Malay breed—one sovereign, to R. E. C. Benton, Glasgow.

For the best pair of Fowls, Cochin-China breed—one sovereign, to R. E. C. Benton, Glasgow.

For the best pair of Fowls of any other breed—one sovereign. *No award.*

For the best pair of Capons. *No entry.*

For the best pair of Poulards. *No award.*

For the best pair of Ducks, Aylesbury breed—one sovereign, to the Marquis of Breadalbane, Taymouth.

For the best pair of Ducks of any other breed—one sovereign, to Sir Thomas Moncreiffe of Moncreiffe, Bart., Perth.

For the best pair of Geese—one sovereign, to William Muir, Hardington Mains, Biggar.

The exhibition was more than usually large, but in point of quality the Judges have not reported favourably. There was a want of superior birds generally, and the deficiency was particularly noticeable in the section of Dorkings.

DAIRY PRODUCE.

Judges.—Robert Greig, merchant, Perth; Charles Matthew, merchant, Perth; Francis Richardson, Edinburgh; Lawrence Rintoul, merchant, Perth.

For the best sample (not less than 14 lb.) of Butter, cured in 1852—three sovereigns, to Adam Roy, Broadlees, Dunblane.

For the second best—two sovereigns, to James Gibson, Pitlochrie, Perthshire.

For the best sample (not less than 14 lb.) of Powdered Butter—three sovereigns, to James Patrick M'Inroy of Lude, Blair-Athole.

For the second best—two sovereigns, to Mrs William Sutherland, Dalmore, Alness.

For the best sample of Fresh Butter, three rolls, of ½ lb. weight each—three sovereigns, to Lady Louisa Moncreiffe of Moncreiffe, Perth.

For the second best—two sovereigns, to Sir John Stuart Forbes of Pitsligo and Fettercairn, Bart.

For the best couple of Cheeses made from Sweet Milk in 1852—three sovereigns, to James Allan, Westmains, Stonehouse, Lanarkshire.

For the second best—two sovereigns, to John Dunlop, Whiteshaw Gate, Strathaven, Lanarkshire.

For the best couple of Cheeses made from Skimmed Milk in 1852—three sovereigns, to Mrs Buchanan, Gilkhorn, Arbroath.

For the second best—two sovereigns, to Thomas Muir, Bowhouse, Lanark.

For the best imitation of any known description of English Cheese—three sovereigns, to M. S. M'Inroy, Lude, Blair-Athole. (*Stilton.*)

For the second best—two sovereigns, to James Allan, Westmains, Stonehouse, Lanarkshire. (*Stilton.*)

The exhibition in this department was, in point of extent, inferior to what has been witnessed in other districts where the dairy forms a more important element in the economy of the farm. In quality, however, it was reported by the Judges as equal to anything they had previously seen, and as highly creditable to the exhibitors. The fresh butter met with special commendation, as well as the samples of imitation English cheese, the Stilton being pronounced equal to any that the county of Leicester produces.

IMPLEMENTS.

Judges.—John Finnie, Swanston, Mid-Lothian; John Gibson, Woolmet, Mid-Lothian; James Horne, C.E., Edinburgh; Alexander Macfarlane, Foundry, Perth; Lawrence Oliphant of Condie, Perthshire; Joseph Scholes, Railway Station, Perth; James Slight, Edinburgh; James Steedman, Boghall, Mid-Lothian; Henry Stephens, Edinburgh; Robert Steuart of Carfin, Lanarkshire; James Stirling, C.E., Edinburgh; William Watson, Errol, Perthshire.

Section 1.—For the best Two-Horse Plough for general purposes—two sovereigns, to George Ponton, Grougfoot, Linlithgow.

The Judges reported a marked improvement in this implement, and stated that the general collection was most creditable to the exhibitors. Seven ploughs were selected by the Judges for trial, the result of which was most satisfactory, and confirmed the opinion previously formed of their different merits. The plough to which the first premium was awarded not only did its work better, but, upon applying the dynamometer, was found to require less power of draught than any of the others selected for trial.

2. For the best Trench or Deep-Furrow Plough. *No award.*
3. For the best Subsoil Plough for two horses. *No award.*
4. For the best Subsoil Plough for moor and stony land, for three or four horses. *No entry.*
5. For the best Double Mould-Board Plough for forming Drills—two sovereigns, to James Barclay, Castleton, Fowlis, Crieff.

The entries in this section exhibited a decided improvement, and justified the Judges in reporting in the same terms as under Section 1.

6. For the best Ribbing or Drill-Paring Plough. *No award.*
7. For the best Two-horse Grubber or Cultivator, working on the flat—two sovereigns, to Robert Law, Shettleston, Glasgow.

The Judges reported an increase in the numbers, and a marked improvement in the simplicity of the construction of this class of implements.

8. For the best Drill Grubber for Green Crops. *No award.*
9. For the best Norwegian Harrow—three sovereigns, to James Kirkwood, Tranent.

The Judges reported most favourably of the implement which gained the first premium in this section. In the trial, it fully maintained the superiority it had formerly shown, and proved itself, upon being tested by the dynamometer, to be of easier draught than had hitherto been supposed.

10. For the best Consolidating Land-Roller. *No award.*
11. For the best Land-Presser for preparing Seed-Bed for Grain—three sovereigns, to David Galloway, Cumno, Alyth.

The Sowing Machine attached to this implement was considered to be a decided improvement.

12. For the best Pulverising Land-Roller—three sovereigns, to Gibson and Richardson, Newcastle-on-Tyne.

The principle upon which this implement is constructed is new to the exhibitions of the Society, and was highly approved of by the Judges upon trial.

13. For the best Harrows—two sovereigns, to William Crosskill, Beverley.

The Bedford Patent Harrow, upon trial, again proved itself superior to all the others that were entered in competition.

14. For the best Common Swing-trees or Draught-bars. *No award.*

There being nothing new in the construction of the articles exhibited, no premium was awarded, but they were commended for their superior workmanship.

15. For the best Equalising Swing-trees or Draught-bars—one sovereign, to James Kirkwood, Tranent.

Though there was nothing new, a premium was awarded by the Judges in consequence of the attention bestowed on the equalisation of the draught, when more than two horses are required, and from the high finish of the implement.

16. For the best Broadcast Sowing-Machine for Grain and Grass Seeds—three sovereigns, to John Lennie, Lauder Barns, Lauder.

The machine to which the Judges awarded the premium is constructed upon an improved principle. It will work better on hilly ground, and is better adapted for removal from one field to another, than those hitherto exhibited.

17. For the best Drill Sowing-Machine for Grain—three sovereigns, to Thomas Sherriff, West Barns, Dunbar.

The Judges reported a general improvement in this class of implements.

18. For the best Horse-Hoe for Drilled Grain Crops—four sovereigns, to Thomas Sherriff, West Barns, Dunbar.

A general improvement in this class was also reported.

19. For the best Sowing-Machine for Turnips. *No award.*

20. For the best Sowing-Machine, for Beans, sowing three rows. *No award.*

21. For the best Dry Manure Distributing Machine—two sovereigns. *No entry.*

22. For the best Liquid Manure Distributing Machine—three sovereigns, to William Herkless, Glasgow.

The Judges deemed this construction of pump as useful in dispersing liquid manure over the ground, and it might also be employed as a water-engine in case of fire at a farmstead.

23. For the best Liquid Manure Pump—one sovereign, to A. and W. Smith and Co., Paisley.

Although this was the only pump entered in competition in this section, the Judges deemed it worthy of the premium, on account of its being made of copper, taking up little room, being easily arranged and removed, pumping liquids effectively, and being moderate in price. Such an implement would be useful in

all sorts of farms, for pumping liquids of any kind at any required place.

24. For the best Straw-Cutter for hand-labour—two sovereigns, to Richmond and Chandler, Manchester.
25. For the best Straw-Cutter for power—three sovereigns, to Richmond and Chandler, Manchester.

Both these machines are of the same construction, the latter being only a little larger than the former. The Judges remarked that they all exhibited the usual high finish and correctness of construction which the machines exhibited by Richmond and Chandler at former Shows of the Society possessed. They also observed that the gearing now employed is much more simple, and fewer, than those attached to similar machines exhibited by that firm, and in consequence they are more generally useful, and their price more moderate.

26. For the best Turnip-Cutter for sheep—two sovereigns, to James Kirkwood, Tranent.

There was considerable competition in this section. The Judges preferred the one made by James Kirkwood, because it is wholly composed of iron, not likely to go out of order, and is so constructed that it can either be wrought by hand or attached to a cart; and it has the further advantage, while travelling over grass land, of cutting the turnips for stock. That of Carson's construction, exhibited by Lord Kinnaird, was commended, on account of its cutting a large quantity of turnips in a given time; but it cut them too small for cattle; and yet, were the turnips mixed with chaff, it seems well adapted for even that species of stock. Smith & Co. of Paisley exhibited a turnip-cutter by hand-power, whose action is horizontal; and it can slice turnips for cattle at one end, and for sheep at the other, at the same time.

27. For the best Turnip-Cutter for Cattle—one sovereign, to C. D. Young and Co., Edinburgh.
28. For the best Turnip-Cutter for Sheep, adapted for attachment to a Cart—three sovereigns, to John Hutchison, Craigend, Perth.

Only one competitor appeared in this section; and although the workmanship was slovenly, and the whole machine would admit of much improvement, the Judges considered the principle of its construction good.

29. For the best Linseed-Bruiser for hand-labour—two sovereigns, to Richmond and Chandler, Manchester.
30. For the best Grain-Bruiser for hand-labour—two sovereigns, to A. and W. Smith and Co., Paisley.
31. For the best Grain and Linseed Bruiser for power—three sovereigns, to Richmond and Chandler, Manchester.
32. For the best Bean-Bruiser for hand-labour. *No entry.*

The bruisers by Richmond and Chandler were highly finished

and efficient, bruising either grain or linseed, the feed of the grain being regulated by a screw. The grain-bruiser of Smith & Co. would bruise the largest quantity of grain in a given time, the feed being regulated by the common clack, but the Judges conceived that the rollers would be materially injured were nails or stones by any accident to get amongst the grain.

33. For the best Root-Washer. *No award.*

34. For the best Steaming Apparatus for preparing food—three sovereigns, equally between Richmond and Chandler, Manchester, and A. and W. Smith & Co., Paisley.

Both these steaming apparatuses were deemed by the Judges useful for both large and small farms, and either may be made double or single as desired.

35. For the best set of Troughs for Feeding-Byres. *No award.*

The Judges awarded no premium in this section, deeming clay to be an unsuitable material for pigs' troughs in a farmyard, and considering the iron pig-trough exhibited inconvenient and clumsy.

36. For the best One-horse Farm-Cart—three sovereigns, to Alexander Scrimgeour, Methven, Perth.

Alexander Scrimgeour's cart is strong and substantial, well adapted for farm purposes, durable, and moderate in price, (£9.) That by Alexander Young the Judges strongly commended as being well put together, but it is high in price, (£13,) its excellence consisting in binding the fore and back cross-bars to the shafts with a bar of iron, instead of bolts. Mr Law's carts exhibited good workmanship and materials.

37. For the best Light Spring-Cart, for farm or other purposes—two sovereigns, to William Crosskill, Beverley.

The Judges deemed this a useful cart; and it is well constructed, like all the workmanship which Crosskill invariably exhibits.

38. For the best Harvest Cart. *No award.*

39. For the best Stone or Iron Stack Pillars, with Framework—two sovereigns, to Young, Peddie, and Co., Edinburgh.

The Judges preferred the stack pillars made by Young, Peddie, & Co., taking the construction, material, and cost into account. Those made by Charles D. Young & Co. they commended as being well constructed.

40. For the best Hay Tedding Machine—two sovereigns, to Richard Hodgson of Carham, Coldstream.

41. For the best Horse Stubble or Hay Rake—one sovereign, to Lawrence Oliphant of Condie, Perth.

This hay-tedding machine is of English origin, and it has not yet been adopted by Scottish farmers, from some preconceived notion that it is not suited for the making of artificial grasses into

hay. However this may be, the Judges believe that a more efficient machine for effectually tedding hay can scarcely be constructed. The agricultural public is much indebted to Mr Hodgson for showing them the really useful purposes of this machine. The improvement on the hay-rake by Mr Oliphant consists in strengthening the axle, by extending its bearings. The workmanship of James Kirkwood's hay-rake was commended by the Judges. All the machines of this section were remarkably well constructed and manufactured.

42. For the best Improvement on any part of the Thrashing Machine—five sovereigns, to Peter M'Lellan, Bridge of Earn, Perth.

Three improvements have been effected in parts of the ordinary Scotch thrashing-machine by Peter M'Lellan. One consists in simplifying the shaker, by removing a number of the teeth, and introducing a brush, to sweep the loose grain into the hopper of the fanners. Another improvement is the introduction of the diamond beaters upon the drum, by which the grain is more easily and effectually separated from the straw than by the common beaters; but the chief improvement is effected in the elevators, by which the roughs are taken from the under to the upper barn in an effectual manner, by a simple means, economising the power. The Judges conceive that the small thrashing-machine exhibited by Macartney and Drummond in this section is of very superior workmanship; and they regret that the placing it in this section—which they consider a wrong one for it—deprived them of the power of awarding a premium to it.

43. For the best Thrashing-Machine, not exceeding two-horse power—six sovereigns, to Robert Steuart of Carfin, Lanarkshire.

The portable English thrashing-machine, introduced into this country by Mr Steuart of Carfin, was made by Edward Pellew of Plenty, Berkshire, is a neat, compact, well-constructed machine, and can be easily moved from place to place. If it had a ratchet gearing, to counteract any inordinate force of the working power, and a stronger spur-wheel, the Judges conceived that this would be a very perfect portable machine. Mr Crosskill's portable machine, which was commended by the Judges for its workmanship, is quite suitable for small farms. It may be well here to refer the reader to the comparative merits of portable machines, which are discussed in a paper of this number of the Transactions, at p. 382.

44. For the best Thrashing-Machine, with English high-speed open Drum, combined with Shakers, Fanners, &c., on the Scotch principle. *No entry.*

45. For the best Barley Hummeler, for attachment to a Thrashing-Machine. *No entry.*

46. For the best Dressing Fanners for Grain—three sovereigns, to Robert Reid, Leysmill, Forfarshire.

The Judges considered the fanners were of superior description.

That exhibited by Robert Reid was well constructed, and the riddling and dressing part superiorly adapted to produce a sample of clean grain. The driving wheels being judiciously placed out of the way is a distinguishing feature of this machine. Smith & Co.'s dressing fanners displayed good workmanship, and were commended.

47. For the best Weighing Machine for the Barn, indicating measure and weight of grain at one operation. *No entry.*
48. For the best Weighing Machine, indicating from 1 lb. to 2 tons—three sovereigns, to A. and W. Smith and Co., Paisley.

The characteristic distinction of Smith & Co.'s weighing-machine is the enclosing of the machinery within a cast-iron box, which may be placed anywhere in the ground, without the aid of masonry.

49. For the best Churn worked by hand—two sovereigns, to Peter M'Lellan, Bridge of Earn, Perth.
50. For the best Churn worked by power—two sovereigns, to Charles D. Young & Co., Edinburgh.

The competition in churns was extensive; but the Judges could not fail to observe that a tendency is manifested by the manufacturers to introduce a complication of machinery in connection with the moving power—a tendency which they consider ought not to be encouraged by the Society. The premium churn, of the box description, was of the simplest construction; and although of itself consisting of zinc, which is objectionable, the form could as well be made in wood. The commended churn of Philip Hunter of Edinburgh was of the old upright form, but furnished with a double plunger, set in motion by means of simple cranks. The churn worked by power was of rather objectionable form, inasmuch as the ropes which govern it are apt to slip off in the operation. But as the implement was well manufactured by Charles D. Young & Co., the Judges awarded the premium.

51. For the best Cheese Press—one sovereign, to Macartney and Drummond, Cumnock, Ayrshire.

There was considerable competition in this section, and the Judges preferred the one by Macartney and Drummond, because of its simple form and inexpensive cost. That exhibited by Richmond and Chandler is of very compact form, and exhibiting beautiful workmanship was commended.

52. For the best Curd-Cutter for Dairy purposes. *No award.*
53. For the best general Set of the Smaller Utensils of the Dairy. *No entry.*
54. For the best Field-Gate, constructed entirely of Iron—one sovereign, to Thomas Gorrie, Perth.

The iron field-gate of Thomas Gorrie was remarkably neat, and strongly constructed, with diagonal bars, and moderate in expense,

and seems well adapted, in the opinion of the Judges, for field purposes. The tension bar-gate of Charles D. Young and Co. was commended as a well-constructed article. There was considerable competition in this section.

55. For the best Field-Gate, not constructed entirely of Iron. *No entry.*
56. For the best set of Travis Divisions, Rack and Manger, for Farm Stables—two sovereigns, to Charles D. Young and Co., Edinburgh.

The Judges considered that such iron heel-posts, iron skeleton frames for the travis-boards, together with the iron rack and manger, would be well adapted for farm stables.

57. For the best set of Farm Harness—premium equally between James Dunlop, Haddington; Hunter and Allan, Kelso; and Alexander Russell, Pitmachie, Aberdeenshire.

The Judges could not but consider the advances made at this Show, in the improvement of farm harness, as very remarkable, no less than three different modes of adjusting the shape of the cart saddle to the back of the horse being presented in competition; and the advantages presented by each were so obvious, that it was impossible for the Judges to draw a distinction between them. So they recommended to the Directors to give a premium to each of the three competitors. Both the material and workmanship of the harness, which was nevertheless very simple in construction and inexpensive in cost, were objects of admiration.

58. For the best Machine for making Drain Tiles and Pipes from Clay. *No entry.*
59. For the best Machine for separating extraneous matter from Clay, and preparing it for the Manufacture of Tiles and Pipes. *No entry.*
60. For the best Machine for Milling, Screening, and Moulding Clay into Tiles and Pipes, by a continuous operation. *No entry.*
61. For the best set of Tiles and Pipes for Field Drainage—one sovereign, equally between James M'Alpine, Stirling, and Alexander Meldrum, Seafield Tile-works, St Andrews.

All the draining materials of this section were excellent in the opinion of the Judges. They could not determine the superiority between the articles produced by James M'Alpine and Alexander Meldrum, so the premium was divided between them; and those of the others were very little inferior to the prize articles.

62. For the best set of Glazed Socketed Pipes for Sewerage—one sovereign, to the Aberdeen Brick and Tile Company, Aberdeen.

This was also a well-contested section, and the Judges only after much difficulty awarded the premium to the Aberdeen Brick and Tile Company, because their prices were the lowest, and the sockets and bends exhibited by them were particularly good, and reasonable in price.

63. For the best set of Tools for Cutting Field Drains—one sovereign, to William Cadell, Sons, & Co., Cramond.

64. For the best set of Tools for Cutting Open Drains in Hill Pastures—one sovereign, to William Cadell, Sons, & Co., Cramond.

The quality of the tools made by William Cadell, Sons, & Co. is well known and generally appreciated, so the Judges had no hesitation in awarding the premiums to them, although they were the only competitors in the section.

65. For the best general set of Hand Implements for the Farm. *No entry.*

66. For the best Apparatus for preparing Flax—ten sovereigns, to A. & W. Smith & Co., Paisley.

Smith & Co. exhibited a complete set of apparatus for preparing flax for the manufacturers, which manifested much ingenuity in construction, neatness of workmanship, and apparent durability in the materials. Although no other competitor appeared, the Judges awarded the premium with much satisfaction to this most effective series of machinery. The preparation of flax by means of improved machinery, and by a different party from the grower, is now eliciting much solicitude, as well in farmers as in manufacturers, especially in Ireland.

67. For the best Reaping Machine—twenty sovereigns, to George Bell, Inchmichael, Errol.

The account of the trial will be found below.

EXTRA IMPLEMENTS AND MACHINES, AND GENERAL COLLECTIONS.

The report by the Judges of this department, after a careful examination of all the articles submitted to their consideration, was of a very favourable character. In many instances the style of construction, the mode of finish, and the mechanical skill displayed, reflected great credit on the manufacturers. Besides this general expression of opinion, the Judges reported the following list of articles which were thought more especially deserving of commendation :—

An eccentric grinding mill, by William Crosskill, Beverley. This article deserves notice for its superior workmanship and its portability. Machine-made cart-wheels, by the same, were of excellent quality and moderate in price. Kirkwood's grubber, by James Kirkwood, Tranent, possessing the usual excellence in form and workmanship of the maker. Sheep fodder rack, by the same.

Double mould-board or drill plough, by Thomas Reid, Monkton Miln. The plough is combined with an apparatus that sows turnip in one drill, while the plough is setting up the one adjoining. It was tried on the field, and found to work satisfactorily.

Grass-mowing machine for horse-power, by Alexander Shanks & Son, Arbroath, for mowing and rolling lawns. This implement

is after the model of Budding's famed mowing machine, and is constructed in Messrs Shank's usual handsome style.

Portable steam-engine, six-horse power, exhibited by A. and W. Smith and Co., Paisley. It was manufactured by Clayton and Shuttleworth, Lincoln. In the opinion of the Judges, its power is over-estimated, but the workmanship was in every respect admirable, and Messrs Smith are entitled to credit for their public spirit in bringing it down from England.

Stack ventilator, by Francis Somner, Kelso. This is a square tube of deal, rising up through the centre of the stack, and crowned with a ventilating hood above the apex. The tube is all over perforated to admit air, and at bottom furnished with four radial hollow arms, through which the current of air is first received. The principle seems sound, though the tubes appear small for their duty.

Draining pavement bricks, by John Quarton, Cuttlehill, Inverkeithing—patentee, William Forbes, Ellon—for the floors of byres and feeding-houses, combining the advantage of the sparred floor with that of solid pavement.

Sheep-dipping apparatus, by Thomas Bigg, London, well known for its economy and efficiency.

Machine for making staples for wire-fencing, by Thomas Dover, Pitlochrie, a new and useful invention.

Improved bee-hives, by Robert Halket, Perth.

Dog-cart, with balancing apparatus, by George Thomson, Stirling.

A complete assortment of the implements and machines used on a farm, exhibited in their actual working condition, by the Right Hon. Lord Kinnaird. This was the most interesting and useful group in the implemental department. The greater part of the articles were by makers of eminence, while a few had been constructed or improved under his Lordship's own direction, assisted by his intelligent manager, Mr M'Laren. Of these last there may be noticed an improved grass-seed sowing machine, possessing every qualification for performing that process in the best manner; also a Carson's turnip-cutter for sheep, fitted up in superior style, and an interesting combination of a gigantic straw-cutter, fitted for occasional attachment to the thrashing machine, when the entire discharge is cut down for litter, in lengths from 4 to 6 inches.

A general collection of implements, by James Slight, Edinburgh, presenting considerable variety, amongst which the following are more specially noticeable: The Tweeddale subsoil and trench ploughs, a Howard's wheel plough, light subsoil trench-plough, diamond and rhomboidal improved harrows, oilcake breaker, and dynamometer. Mr Slight was found entitled to high commendation for his collection; and it should be noticed that on this, as on former occasions, he might have been ranked

among the successful exhibitors in the premium sections, were it not that, owing to his official connection with the Society, he declines to compete for its premiums, though always ready to add to the usefulness and attractiveness of its Shows.

Collection of articles in fire and common clay, by the Grangemouth Coal Company, embracing fountains, vases, pedestals, &c., and displaying great artistic taste.

Collection of articles in fire-clay, from the works of John Wauchope, Esq. of Edmonstone, consisting of vases, pedestals, chimney-tops, &c., of very elegant designs. Particular attention was drawn to a fire-clay oven for kitchens, handsomely mounted with metal door, &c.

Collection of wire-netting, and articles of like manufacture, by Thomas Gorrie, Perth. The wire netting was remarked for its substantial quality and moderate price.

Collection of iron hurdles, garden-chairs, and other articles in wrought-iron, &c., by Charles D. Young & Co., Edinburgh. The leading article—the hurdles—in this collection, were of the usual substantial construction and good workmanship of this well-known house.

A large collection of gates, hurdles, wire netting, and other wire works, by Young, Peddie, & Co., Edinburgh, exhibited tasteful and substantial examples of the manufacture of this establishment. A wrought-iron carriage gate, with side wickets, was particularly noticed.

REPORT OF THE TRIAL OF REAPING MACHINES.

Out of five Reaping Machines exhibited, four were on the principle of Hussey's, and one on that of the Rev. Patrick Bell. Of these, only two were entered for trial. The Hussey machine was from the well-known house of Crosskill of Beverley, the other was the early constructed Scotch machine, invented in 1828 by Patrick Bell, with certain improvements lately introduced by his brother, George Bell, of Inchmichael farm, Perthshire.

As has already been stated, arrangements were made by the Secretary to conduct the trial on the farm of Muirton, and three fields—oats, barley, and wheat—were placed by Mr Morton, the tenant, at the disposal of the Society for the experiment.

The following Judges were appointed to superintend the trial:—Lawrence Oliphant of Condie; Henry Stephens, author of *The Book of the Farm;* James Stirling, Civil Engineer, Edinburgh; John Finnie, Farmer, Swanston; John Dickson, Farmer, Saughton Mains; John Gibson, Farmer, Woolmet; James Steedman, Farmer, Boghall; William Watson, Millwright, Errol; John Young, Engineer, Newton-upon-Ayr.

The practical farmers to whom the duty was intrusted were purposely selected from districts unconnected with the Perth Show, so as to be free from any bias which possibly might have been

ascribed to those in whose neighbourhood Bell's machine has long been in operation. His Grace the Duke of Athole, with his characteristic energy and activity, superintended the whole arrangements; and Hugh Watson, Keillor, attended the trial as arbiter between the Society and the Tenant, in the event of any question arising as to damage sustained by the crops. Owing, however, to the orderly conduct of the vast crowd of spectators, Mr Watson's services were not required.

A space was first cut by the sickle along the ends of the fields, so as to enable the machines to commence. Hussey's, from being *drawn* by the horses, requires a further clearance along the sides sufficiently broad to allow the horses to walk. Bell's, on the other hand, being *propelled* by the horses, and having the power of delivering the grain to the right or left, opens a passage for itself at any point, whether at the side or in the centre of a field; hence in each trial it took precedence in starting. Each machine was worked by two horses.

The first essay was in a field of oats. The crop was standing and nearly ripe, consequently in a favourable condition for machine-cutting, although it stood rather thin on the ground. Bell's machine at first created an impression, from the slow movement of its shears, (making only about 110 strokes per minute,) that it might pass over and crush the grain. A second or two, however, sufficed to dispel this; and as the implement progressed, it left a stubble about four inches high, cut with the most perfect regularity, and so clean that scarcely a straw or a grain was observable on it. A stoppage occurred to allow some adjustment to the height of stubble, and, during the five or six turns made by the machine, two or three stoppages took place in crossing deep furrows and unequal ground; but, on the whole, the work was well and continuously performed. The cutting was perfect throughout, and the corn laid with great regularity in an unbroken swathe, the straw lying at an angle of 30° with the line of progress. The breadth of the cut, when shut on both sides, is 6 feet, but cutting with an open side, the breadth seems not to exceed $5\frac{1}{2}$ feet. In the present case the average of four turns was only 5 feet.

Hussey's machine next came into operation on the oats. The rapid vibration of its cutters, which gave about 570 strokes per minute, produced a feeling of confidence at the start that it would leave nothing uncut; and the first turn, though not performed without stoppage, was satisfactory with respect to cutting. The grain, however, was not so well laid as by Bell's, and the stubble was higher and not so clean. The succeeding cuts were less satisfactory, frequent stoppages occurred, and when there was any under-growth of grass, the machine was greatly baffled. While the operation of cutting was fairly performed, it was evident that the radical defect of the machine lay in the want of sufficient and regular means for removing the grain when cut. This division

of the process depended exclusively on the rakeman, and when he missed the proper moment for removal, the cutters were immediately choked. In point of economy, a most important defect was observable—the breadth cut by Hussey's did not, on an average, exceed 3¼ feet.

The barley crop was much heavier than the oats, and partially laid, thus presenting greater difficulties to the machines. The superiority of Bell's was here decided in every respect, while the more frequent stoppages of Hussey's, from choking, seemed to be caused partly by the greater weight of the crop, but mainly by the inability of the rakeman to perform his duties under the combined difficulty of a partially matted and a heavy crop.

In the wheat field the crop was of great weight and strength, estimated at a produce of six quarters the imperial acre; and here the decided superiority of uniformly continued mechanical action over intermitting muscular force was strikingly illustrated. Bell's machine, at the outset, cutting a breadth of 5½ feet along the edge of a ditch, had a stoppage from inequality of surface, after which it proceeded almost without intermission, cutting its regular breadth, and laying the wheat with great regularity, three or four straws only being seen out of the proper angle on the top of the swathe. Under this ordeal, Hussey's had still some merit. It cut a fair stubble, though higher than desirable. It began with its usual breadth, but even that (small compared with Bell's) was beyond the powers of the rakeman to remove; the machine consequently became choked at intervals of a few yards, and it ultimately appeared necessary to reduce the breadth of cut to about two feet. In the wheat, therefore, the comparative failure of this machine was, under any economical view, obvious and decided. The action of the fan in Bell's machine, in gathering and depositing the crop upon the web, induced an apprehension that the grain might to some extent be beaten out. This the Judges carefully investigated, and found to be groundless.

Taking into consideration all the circumstances of these trials, the Judges unanimously felt warranted in awarding the premium to Mr Bell, for the following reasons:—

1*st*, For the decided superiority of his machine in economising time and expense, owing to the greater breadth cut by it with the same horse-power—the difference being as 10 to 6½.

2*d*, For the character and quality of the work performed by it, as being cleaner cut, producing less waste or shake, and laying the swathe with a regularity better suited for binding in sheaves than when laid off in unequal bundles.

3*d*, For being less liable to choke, and to the consequent stoppages.

4*th*, For being mechanically adapted to deposit the grain in rows, performing the operation in a superior manner, and saving, in the opinion of the Judges, the labour of two men, as compared with Hussey's.

5th, For the advantages arising from its having the means of laying off the grain to the right side or the left, this feature, combined with that of being propelled instead of being drawn, enabling it to enter on either side, or into the centre of a field, without any previous clearing, and to continue the cutting without interruption while the cut portion of the crop was lying on the ground.

6th, For greater efficiency when operating on a crop partially lodged.

JN. HALL MAXWELL, *Secretary.*

SUMMARY OF THE DISCUSSIONS AT THE MONTHLY MEETINGS OF THE SOCIETY IN 1851-2.*

By THOMAS ANDERSON, M.D., Chemist to the Society.

I HAVE selected for the subject of the following address a summary of the discussions at the monthly meetings of the Highland and Agricultural Society during the past winter, and I have done so for several reasons. It has appeared to me that these meetings have now become an essential, and, as I think, a very important part of the business of the Society, and that there could not be a more favourable opportunity of referring to them than that afforded by the General Show, when a larger number of the members is gathered together than at any other time; and that these meetings may in this way be brought under the notice of many persons, who might not otherwise pay to them that attention which the importance of the subjects discussed, and the valuable observations of the different speakers deserve. I have been influenced also by the belief that the system of holding such meetings admits of much extension, and that what has been done by the Society as a great national institution might be carried out by local clubs with great advantage, not only to their members, but to agriculture at large. To a certain extent this has already been done, for several local clubs hold meetings for discussion; and I can speak from personal experience of the admirable manner in which the business of such of them as I have had an opportunity of visiting is conducted, and the benefit they have conferred on their district. A local club which holds discussions I have always observed to be the centre of an increased amount of skill and energy; in its district the agriculture is always more advanced, and there is a readiness to adopt what is new, tempered with a sound discretion, which prevents the rash and indiscriminate trial of all novelties, but confines it to such improvements as a sound knowledge of the capabilities of the district render probably successful.

The interchange of opinions between man and man is fraught with advantage in every branch of knowledge; but it is peculiarly

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* Dr Anderson delivered this address on the occasion of the General Show at Perth in August last.—ED.

so in agriculture, for an individual who is isolated from his neighbours is apt to fall into a routine, which he has found to insure a certain amount of success, and becomes indisposed to adopt what might probably be improvements. Many a man, too, has not the opportunity of learning from books the progress of agriculture, or, if he has, he is often unwilling to alter his practice, either from a doubt, which is very commonly, and to some extent correctly entertained, regarding the efficiency of mere book learning in his art, or from that *vis inertiæ* of which every man has more or less in his composition. But make him a member of a club, in which he hears the very same matters discussed by word of mouth, and the pros and cons distinctly pointed out by men whom he knows to be successful farmers, and he is stimulated to inquire how far they may be applicable to his own case, and to try them either in their integrity, or with such modifications as may appear necessary to suit them to the requirements of his own farm. But there is another advantage which such meetings afford, and which is prominently brought out by the discussions which I am about to bring under your notice: they have a tendency to improve not merely the practice of the art, but to direct the attention of practical men to the principles on which that practice depends; and it is impossible to look carefully into any of them, without observing a constant reference to scientific principles, and a concordance between the inferences of science and the results of practice, which most convincingly indicate that we are slowly though surely establishing a correct basis for agriculture, elevating it from the rank of an art to that of a science, and raising it to that position which it deserves to hold, not merely from its material importance, but from its real interest as a branch of knowledge.

The discussions of the past season have been four in number:—

1*st*, The best modes of feeding and housing fattening cattle, and the breeds most suitable for different districts.

2*d*, Turnip culture.

3*d*, On the value, in point of economy, immediate effect, and durability, of guano and other special manures, compared with farm-yard manure, the produce of turnips alone, as well as conjoined with cake, grain, or other extra feeding.

4*th*, On the cultivation of flax;

and in considering them I shall endeavour less to give the opinions of the individual speakers than to point out the general scientific inferences which may be deduced from the whole discussion; and though two, at least, are mainly occupied with practical details, I think I shall be able to show that even they have a foundation of scientific principles.

1. The first of these subjects of discussion, "On the best modes of housing and feeding fattening stock," naturally divides itself into three different sections, which most of the speakers have considered separately. On the first head, (that of housing,) all refer to the

gradual change which has taken place in the mode of accommodating fattening cattle, and the abandonment of large open courts containing from ten to twenty cattle, and the introduction, first of hammels or small courts, with sheds for the accommodation of two or at most three cattle, then of stalls, and still more recently of boxes. The concurrent testimony of all is strongly condemnatory of the first of these practices, and reference is very distinctly made to the scientific facts on which its inferiority depends. It has been conclusively established by scientific inquiry, that the natural temperature of the animal body is sustained by the consumption of a certain quantity of its food, which during the process of respiration undergoes a change chemically identical with that which takes place in the act of combustion. But in the animal body the temperature is always the same, whatever be that of the surrounding air. If, for instance, an ox be examined, its temperature will be found by means of the thermometer, during the dead of winter and the height of summer, to be always the same; and on Fahrenheit's thermometer it will be somewhere about 100 degrees, while that of the air may in the one case be under the freezing point, and in the other as high as 70 or 80 degrees. Now it is very obvious that, in the former case, a much larger quantity of food must be consumed, to sustain the temperature of the animal at 100 degrees, than is necessary in the latter—just as a room requires more fire to keep it hot in the winter than during the warmer seasons of the year; and it naturally follows, that if we keep the animal in a warm locality, we economise the fuel, and require to supply a less quantity of food to keep up the temperature of its body at the natural standard. Now this is exactly what is effected by the improved methods of housing cattle; for while, in the large open court formerly universally employed, they were exposed to every vicissitude of the weather, in the smaller courts with sheds, or still more in houses, they are protected from the extremes of temperature, and an economy of food effected. A certain quantity of food is capable, under favourable circumstances, of producing a certain quantity of fat: but if the temperature of the air falls, an additional quantity of fuel is required to sustain the animal heat; and science has shown that the elements so consumed, or burned off, are exactly those which, under any circumstances, would go to the formation of fat. It is obvious, therefore, that if we keep the animal warm, we do what would otherwise be done by a portion of the food with which we supply it; and we might be inclined to say that the warmer it is kept the better. But practically there is a limit to this: there is a certain range of temperature which is natural to the animal; and though, in the process of fattening, we place it to a certain extent in an unnatural condition, we cannot carry this too far without producing various derangements of the system, which would speedily end in positive disease. Our object, therefore, must be to sustain only a certain proportion of

the internal temperature by external warmth; for the production of a considerable part of it, by the combustion of the food within the body, is connected with and essential to the healthy performance of the animal functions.

But there is another source of waste of food which these improved means of housing are also calculated to prevent. It has been ascertained that not only is the temperature sustained at the expense of the food, but that every movement of the muscles produces also a certain consumption of it. Thus, if we sit still for an hour, a certain amount of the food we have swallowed is consumed or burned off in our bodies, which can actually be measured, by particular and very complicated chemical experiments; but if we run violently, or engage in any active muscular exertion, the quantity which undergoes combustion is greatly increased. Now, obviously, if we confine a number of cattle in a large court-yard, which admits of abundant exercise, we produce the conditions of an increased and uneconomical consumption of food; while, if we confine them in a small space, we diminish the muscular exertion, and consequently the amount of food which is wasted by it. And this is what is actually carried into effect by the use of hammels, stalls, and boxes, which, by the smallness of their space, prevent the animal taking an undue amount of exercise. In this, however, as in the former case, there is a limit, for exercise to a certain extent is absolutely requisite to the healthy performance of the functions of the animal.

The object, therefore, of the careful feeder, is to reduce the consumption of food, by these two necessary processes, to the smallest quantity consistent with the perfect health of the animal; and I need hardly say that practice is here fully consistent with theory, for the speakers, one and all, concurred in upholding the superiority of the methods adapted to secure these results, while they all condemn the use of open courts, which expose the cattle to the vicissitudes of the weather, and admit of active exercise. Minor differences of opinion, however, exist as to which of the other methods of housing presents the greatest advantages; but those differences, as Mr Elliot remarks in his observations, may be readily and fairly attributed to differences of climate and locality; for while hammels, which permit a certain amount of exposure to the weather, may be quite successful in a low and sheltered locality, they may be equally unsuited to an upland and cold district. The balance of opinion, however, is in favour of box-feeding, which is well spoken of by all those who have given it a fair and extended trial. It fulfils, in fact, all those conditions to which we have just referred, and possesses the important practical advantages of economy in the expenditure of labour in feeding, and the production of a manure of superior quality. This superiority of manure, though referred to by several speakers, is not discussed in detail; nor, so far as I know, are there at the

present moment any satisfactory experiments to substantiate it; and though I think it probable that a certain degree of superiority is produced, I should, on theoretical grounds, hesitate to express a decided opinion. It is most desirable, however, that we should obtain facts which may enable us to do so, and I would suggest the subject as one which merits examination by careful experiment on the farm.

The second part of the subject—the method of feeding—was not gone into in such full detail as it was at one of the discussions of the previous year, but various observations fell from the different speakers which are deserving attention. Mr Elliot insists, particularly, on the advantage of giving a considerable variety of food; and this, which is his opinion, founded on actual experience, is fully borne out by science, and is peculiarly interesting to me, as I have more than once referred to it, on scientific grounds, as a proper practice; for, theoretically, the more we can vary the forms in which the elements of food are supplied to the animal, the more likely are we to promote active and healthy digestion, as well as to hit the proper proportion in which these different constituents ought to be present. It has been established that there are two great classes of compounds which the food must contain, one of which, including the saccharine and oleaginous substances, forms the true fuel of the animal body, of which one part goes to sustain its temperature, while another is laid up in the system in the form of fat, to be used as fuel in any emergency to which the animal may at a future period be exposed. The other class includes what chemists call the albuminous or proteine compounds, which go to the production of the true flesh or muscular fibre. Now, the successful fattening of the animal can only be effected by supplying it with food, which contains both classes of constituents in certain proportions. All the substances employed in feeding are not of this kind, and we require, therefore, to mix them together, so that the deficiencies of the one may be made up by another. Mr Christie has given us a curious illustration of this. On one occasion, when beans were extremely cheap, he gave 6 lb. each to a lot of sixty cattle, and he found that for several months they did well; but about the end of that period their coats became rough, they appeared not to relish their food, and some of them refused it entirely. In this case there was supplied to them a quantity of food, rich in albuminous, but deficient in saccharine or oily elements, and the proper proportion of these two being thus deranged, the functions of the animal were imperfectly performed; but no sooner did Mr Christie reduce the quantity of bean-meal to 2 lb., and substitute for the remainder 4 lb. of oilcake, than they immediately began to improve, and were soon sold in excellent condition. But even when the proper proportion is preserved, much advantage must be derived from varying the food, because the albuminous, oily, and saccharine matters are not chemically identical in all;

and it is consistent with all we know of the phenomena of nutrition, to afford to the animal a supply of them in as varied forms as we can.

Mr Elliot, in referring to the possibility of profitably employing the grain produced upon the farm in feeding, has touched on a subject of much importance, and which has engaged a good deal of my attention. He has given an illustration from his own practice of a case in which, after allowing a proper price for the turnips and grass consumed, he obtained 3s. per bushel for his oats, and 4s. for his beans, at a time when the market prices were 2s. 3d. and 3s. 4d. respectively. If such profits could always be obtained, there could be no hesitation in adopting the practice; but I confess I cannot help thinking this to be an extreme case, though I am at the same time convinced, from a comparison of the nutritive value of those substances, that better profits may often be obtained in this way, when prices are low, than by sending the grain to market. I shall not attempt here to state the grounds of this opinion, as the full discussion of the subject would occupy much time, and lead me altogether away from the matter in hand.

In referring to the last branch of this discussion, (that of the best breeds of cattle,) I approach a subject very foreign from my pursuits, and of which I must simply profess my ignorance. But I may be permitted to offer one or two observations, which naturally suggest themselves to any one hearing the remarks of the speakers. I need scarcely say that the short-horn receives the general support, but it is easy to see that its peculiar advantages open up a question, which may have the effect of producing a very important change in agricultural practice. In fact, if the farmer goes into the market for the purpose of buying cattle for feeding, it does not much matter what breed he takes, provided he gets them cheap enough to leave him a profit on his expenditure of food and labour; but it is quite another thing if he breeds the animal himself, for in that case the advantage is enormously in favour of the short-horn, from the rapidity with which it arrives at maturity, and its disposition to lay on fat. Mr Wilson, who refers to this fact, gives some interesting illustrations of it, which, however, do not admit of being curtailed. It would appear that this early maturity is peculiar to the short-horn, but it may be asked whether this is necessarily the case? and, also, how far their treatment produces this superiority over the other breeds? The short-horn, as the superior breed, is bred in the best districts, nurtured with every care, and supplied with abundance of nutritious food: contrast this with the Highland breed, for instance, passing its early life on an exposed hillside, and fed on its scanty herbage—the one placed in circumstances to force it on to early maturity, the other in those to repress it, and even to stunt its growth; and the question presents itself, as to what would be the effect of affording to

the latter the same generous treatment which the former receives. It seems to me quite possible that the inferior breeds might acquire the peculiarity of arriving at early maturity in a greater or less degree. Perhaps such experiments may have been made already; but if so, I have not chanced to meet with any account of them.

2. Of the second discussion (that on "Turnip Culture") I fear I shall be able to give only a very unsatisfactory account, the statements of the speakers entering into all the minutiæ of the methods of cultivation, with a fulness of detail which renders the discussion very interesting to those who are inclined to study it in full, but makes the task of abstracting it very difficult indeed. I shall not, therefore, attempt to go into all the particulars of the preparation of the soil, which I should certainly fail to make interesting to you, but shall confine myself to such points as appear to me to lead to scientific inferences. The turnip crop has now become so essential a part of our system of husbandry, that it is with a strange feeling we look back, and find that its cultivation as a field crop dates from no more distant period than the middle of the last century, while so important has been its influence, that its introduction has, without doubt, produced a revolution in agriculture as rapid and as remarkable as that occasioned by the steam-engine in the mechanical arts. The turnip is interwoven with the whole history of agricultural progress; it is the pioneer of improvement, and the foundation of good cultivation, and that to so great an extent, that we should not err greatly if we take the proportion of land under turnip as the measure of the agricultural condition of any district. It would be very interesting, in this point of view, to trace the gradual rise of its cultivation. In the absence of agricultural statistics it is unfortunately impossible to do so, but facts enough are adduced by some of the speakers to show that, during the last fourteen years, (the period of remarkable agricultural progress,) the breadth of land in Scotland under turnips has doubled. But even this does not express the full advance, for there is no doubt that the average crop per acre has also increased in no inconsiderable degree. Mr Elliot has given a very interesting statement of what has been done in Annandale, during the last few years, through the instrumentality of Mr Stewart of Hillside, which may enable us to form some idea of the extent to which this has occurred. In 1842, a series of queries was issued by that gentleman requesting information regarding the turnip crop; and from the answers received, it appeared that the average crop of swedes that year amounted to 13 tons per Scotch acre. In the subsequent years, a committee of the Lockerbie Farmers' Club went round and weighed the crops on the different farms, and from their returns found that in 1849 the average had risen to 21 tons; in 1850, to 24; and last year, notwithstanding the extensive prevalence of finger-and-toe, it still amounted to about 20 tons. Here

we have an increase on a very unfavourable year of upwards of 50, and on a favourable one of nearly 100 per cent.

If we proceed upon these data, it would appear that the quantity of turnip produced is nearly four times as great as it was fourteen years ago. It is probable, however, that we should in this way considerably exaggerate the increase, for the plan followed by the Lockerbie Farmers' Club would necessarily be a great incentive to good cultivation, and produce a rapid improvement and a high average; the district, moreover, was then a backward one, and it can scarcely be assumed that so great an increase can have occurred in the Lothians and other well-farmed districts. Be this as it may, the fact of a very considerable increase having unquestionably occurred in the average crop, irresistibly impresses us with the idea that we have by no means reached the limit of production, but that we may confidently anticipate the possibility of producing still larger crops. Mr Hope of Fentonbarns has entered into a very interesting calculation to show the possibility, nay, the probability of this. He calculates that there are in round numbers 8000 lineal yards of drills, 27 inches apart, in a Scotch acre. Now, if we suppose there to be 3 turnips per yard, and each to weigh 2½ lb., the total crop would amount to about 27 tons, which is above the average. But when we bear in mind that it is no uncommon thing to see turnips of 10, 12, or 16 lb. weight, it is surely not extravagant to suppose that we might produce an average of 4 or 5 lb.; or, in other words, obtain crops twice as large as we at present do. The question which immediately presents itself is, How is this to be done? For my own part, I do not anticipate its being immediately effected—indeed, I do not think we are entitled in any case to expect rapid advancements in agriculture. They may occasionably occur, when we have the successful introduction of a new crop, but as far as the after-improvement of it goes, we must be content to wait patiently, to watch what is going on, and to adopt any little improvement which time, experience, or science may produce. This, which is true of every crop, is particularly so of the turnip, the successful cultivation of which is dependent on attention to minutiæ. There are two great points which practice tells us we must attend to, and theory also confirms. We must reduce the soil to the finest possible tilth, and manure plentifully with rapidly-acting manures; and we have only to consider the natural state of the turnip to see how essential these conditions must be. As it grows wild, the turnip produces no bulb at all, or at most a little swelling on its root, which may weigh perhaps an ounce or two; and the object of cultivation is to expand this little protuberance into a bulb of two, four, or, if possible, ten or twelve lb. weight. Now it requires no great amount of consideration to see that, if we wish to succeed, we must plant our seed in a loose soil, which shall

admit of being pushed aside as the root expands; for if we place it in a hard or compact soil, where there is any resistance to the expansion of the bulb, we put it in a manifestly unfavourable condition. It is for this reason that stiff clays are unfavourable to the turnip, and it is the opposite peculiarity which has caused particular soils to be distinguished as turnip soils, the peculiar suitableness of which to the turnip is not dependent on their chemical composition, but on their possessing a light and friable texture, which presents little resistance to the pressure of the bulb. Where the soil does not necessarily possess this peculiarity, we must do our best to make up for the deficiency by repeated working; and that necessity is sufficiently strongly insisted on by all those who have discussed the subject. On the other hand, when we take into consideration the large mass of bulb which is to be produced, and that in a very short time, we understand the necessity of affording a liberal supply of manure, of such sorts as produce their effect with rapidity.

On the subject of manuring little difference of opinion exists, and that only in details. A decided preference is given to guano by all the speakers, and particularly by Mr Hope, who informs us that in his hands it has always surpassed every other manure. Mr Elliot, on the other hand, thinks the admixture of different sorts of artificial manures most advantageous, and states as the result of his practice, that a mixture of farm-yard manure, bones, guano, and superphosphate, at an expense of £4, will produce a better crop than any of them separately, at an expense of £5 per acre. As this subject, however, was more fully taken up at the next discussion, I shall not now refer to it at length.

The great difficulty of turnip culture is the liability of the root to the disease of finger-and-toe; and the extent to which it has increased of late years in some districts, is such as to excite most serious apprehensions. To this subject I have for some time past directed my attention, but without arriving at any positive results, except that it is certainly not dependent upon causes on which the analysis of the turnip itself, or the soil in which it grows, can throw light. In fact, the more minutely we inquire into the matter, the more complicated does it become, and the more conflicting are the opinions expressed. When I commenced the inquiry, I was informed by some persons that lime was a perfect cure, by others that it was totally useless; by some that the disease was certainly produced by an insect, by others that it was certainly not; by some that it is produced by the too frequent repetition of turnips on the same land, by others that it occurs with as great virulence on land under turnips for the first time, as on that in which they have been frequently sown. With such conflicting opinions, I felt that more extended information was requisite to enable me to ascertain whether all these opinions were

equally correct, and whether it might not be possible to reconcile them with one another; and accordingly a schedule of queries on the subject of turnip disease has been widely circulated among the farmers of Scotland, which, I trust, may enable us to arrive at some definite conclusions. In the mean time, it seems certain that lime is, in many instances, unequivocal in its effects, and that benefit is generally obtained by making the turnip recur as seldom as possible on the same land. There is just one observation with which I should wish to conclude, and it is this, that we must be careful lest the importance of the turnip, and the highly beneficial results obtained from it, should blind us to the value of other roots. I am not very sure whether this has not been to some extent the case. We very seldom hear, for instance, of mangold wurzel, although chemically it is more valuable than the turnip. The reason assigned for this is, that it is not suitable to the climate of Scotland; but there are some districts in which it can certainly be profitably raised, and I think there are indications of a tendency to produce it more extensively. Should it prove successful on more extended trials, it would form an important substitute for the turnip, and, by protracting the period of its recurrence on the same land, diminish the risk of disease.

3. The third discussion (on the comparative value in point of economy, immediate and permanent effect of guano and other special manures, and of farm-yard manure produced by turnips alone, or by turnips with auxiliary feeding) relates to a matter of the highest importance to the active and improving farmer. It has, moreover, an additional interest, as being one of those subjects upon which science and practice can meet together on a common ground, and are in the condition mutually to explain and assist each other. The introduction of special manures has indeed been the main-spring of the applications of science to agriculture, and has brought home to the practical man the importance of inquiring, as he goes along, into the principles upon which his art depends; it has impressed him with the advantages of looking more deeply than he has hitherto been accustomed to do into its phenomena, and stimulated him to proceed in the path of improvement. The advantages of guano and other special manures are now so universally acknowledged, that it would not have required the confirmation afforded by all the speakers to establish the fact. The most convincing proof is to be found in the gradual increase which has taken place in their use, so that the consumption of guano, which in 1842 did not reach 1700 tons, has now risen to upwards of 200,000. But while nothing further is required to settle this point, many very complicated questions must be answered before we can form a just comparison of its effects with those of farm-yard manure, which many people were at one time sanguine enough to suppose it was entirely to supersede.

I shall pass over with only a few observations the comparative advantages of the different sorts of special manures, which form a very subordinate part of the present discussion. It appears that general experience has established the superior economy of guano, and particularly Peruvian guano, over all other special manures. This superiority, I may, however, observe, is most prominently marked on the better class of soils, and is not so apparent on those which are light and sandy, on which the inferior sorts of guano, such as Saldanha Bay, and bones, often produce a better effect. This is dependent on Peruvian guano yielding a larger quantity of ammonia and a small quantity of phosphates; and as the former, from its solubility, is liable to be rapidly washed away, the main effect on the lighter soils is due to the phosphates; and the manures most advantageous on such, are those which contain the latter substances in largest proportion, as Saldanha Bay guano and bones do. It is on good, and particularly on highly cultivated land, that the benefits of Peruvian guano are principally seen.

Without entering further into this question, I shall take Peruvian guano as the point of comparison, and endeavour, from the facts brought out by the speakers, to estimate its value, compared with farm-yard manure. Taken in its broadest point of view, this comparison is by no means so easy as it at first sight appears. If we had to consider merely the relative effects of the two manures upon a single crop, there would be no great difficulties; but in order to obtain a complete comparison, it is necessary to estimate the amount of unexhausted residue remaining for the benefit of future crops, which is not easy; and an additional complication is introduced, when the question of price is taken into consideration. As far as the immediate effects of guano are concerned, these can be readily estimated; and it appears from the statements of Mr Finnie, quoted by Mr Dickson, that as good a crop can be obtained from 6 cwt. of guano as from 30 tons of farm-yard manure; while Mr Dudgeon, on his part, finds the same effect from 4 cwt. of the former as from 20 tons of the latter. In those cases, 1 cwt. of guano supplies the place of 5 tons of manure; but Mr Finnie is of opinion that, as a general rule, it would not be safe to reckon on that quantity replacing more than $2\frac{1}{2}$ tons. With these proportions, and upon the turnip crop to which it is applied, there can be no question of the utility, and, as we shall presently see, of the economy of guano, though it is admitted that it is still preferable to employ it not alone, but in conjunction with farm-yard manure. When, however, we come to consider its effects on the subsequent crop, some difference of opinion exists, and doubts are expressed. For my own part, I have no hesitation in giving it as my opinion, that it must be inferior; and though it may be possible, by modifications of practice, to render

its inferiority less than it might otherwise be, it must always exist. It is certainly not the case, as was almost universally supposed at its first introduction, that the whole benefits of guano are exhausted in the first season; still it is essentially a rapid manure, and leaves comparatively little for subsequent crops. The unexhausted residue is dependent to some extent on the nature of the soil, and is much larger when that is heavy than where it is light; but under no circumstances is it at all comparable with that left by farm-yard manure. This becomes very evident, when we compare the quantity of valuable matters supplied to the soil by an ordinary manuring with both these substances.

Thirty tons of farm-yard manure, which is a liberal supply, will contain, in round numbers, about 260 lb. of nitrogen—equivalent to 310 of ammonia, and about 450 lb. of phosphates. But 6 cwt. of Peruvian guano, which is a larger quantity than is usually employed, even when no other manure is used, contain only 103 lb. of ammonia and 132 lb. of phosphates. Now, a crop of turnips amounting to 20 tons contains a quantity of nitrogen corresponding to about 108 lb. of ammonia, and about 110 lb. of phosphates; and it is therefore obvious, that at the end of the first season there would remain no ammonia, and only about 22 lb. of phosphates, available for future crops; while in the case of the farm-yard manure, we should still have about 200 lb. of ammonia and 340 lb. of phosphates remaining for future use. It may be urged that, if this calculation be correct, the crops following turnips raised with guano ought to be total failures; and they would be, were not their valuable matters obtainable from other sources than the manure we apply. An acre of good soil, in fact, contains from 1 to 2 tons of nitrogen, and about the same amount of phosphoric acid, and from it a certain quantity of what passes into the plant is taken, but not the whole, for they exist in the soil in a condition in which they are only slowly available; and in all cases where manure is supplied, a larger proportion will be taken from it rather than from the soil.

Notwithstanding this, I have no doubt it may be possible to go through a complete rotation with guano alone; and Mr Dickson has given us an interesting case in which this was managed with a mixture of guano, dissolved bones, rape-dust, nitrate of soda, and sulphate of ammonia; but I question much whether it could be successfully carried out through a series of several rotations, even if we took care to add all the valuable matters removed by the crops; and the reason is, that farm-yard manure not only adds the constituents which the crop has removed, but has another function to perform on the soil itself, the importance of which we are apt to overlook. It is a source of carbonic acid, which is being gradually evolved by the fermentation which is constantly going on in it; and that carbonic acid acts slowly upon the mineral part

of the soil, decomposes and disintegrates it, and brings its constituents into a state in which they are available to the plant. A similar change is also occurring in the organic matter existing naturally in the soil, which will keep this disintegration going on for a certain time, even where no organic matters are added in the manure; but after the lapse of a longer or shorter period, this will be exhausted, the soil itself become comparatively inert, and the plants which grow upon it entirely dependent on substances added from without, and of which a very large supply must be given. In Mr Dickson's case, the soil was rich in organic matters, like all those around Edinburgh; and in the previous rotation it had received no less than 40 tons of farm-yard manure, which may help to explain his success, and may fairly entitle us to surmise that a very different result might be obtained if the same practice were continued through a series of rotations. Indeed, it might be easily shown that the crops in this case must have carried off more nitrogen than they receive in the manures employed, and they must, consequently, have been abstracting it from the soil, the consequences of which must, sooner or later, become obvious.

It may probably be said, that if the statements I have made are correct, that guano, far from being beneficial, ought, in the long-run, to be inferior to farm-yard manure; and it would certainly be so, if we depended upon it alone. Its peculiar advantages are as an auxiliary, which supplies a quantity of certain constituents in an immediately available condition, in which they are requisite for producing the rapid growth of the crop through the early stages of its existence; and the enormous mass of farm-yard manure which must be used where large crops are expected, is dependent to some extent on the small quantity of its constituents which exist in that condition; so that we generally employ a larger total quantity of the valuable constituents of farm-yard manure than is required for the whole rotation, merely that, by doing so, we may get a sufficiently large amount of those which we wish to act rapidly. The peculiar merit of guano is, that, by mixing it with farm-yard manure, we can bring up the quantity of immediately available constituents, without adding unnecessarily to those which are to be long dormant in the soil. The practical fact is, that under liberal management, by farm-yard manure alone, a soil becomes gradually richer in organic matter, ammonia, and phosphates; and it is quite possible, so long as that excess remains, to raise crops by the addition of the rapidly-acting manure alone; but it is a system which the good farmer will only employ under exceptional cases.

On that part of the subject of discussion which refers to the comparative value of manure produced with or without auxiliary feeding, we have little precise information. A vague general opinion seems to exist, that the use of oil-cake, and other foreign food,

does improve the manure; but no experiments are supplied except by Mr Main, who found that a quantity of manure, produced by auxiliary feeding, gave an excess of 3 tons 9 cwt. of turnips over a similar quantity without it. The experiment, however, is a solitary one; and I do not think it desirable to draw very decided conclusions from a single experiment in such a case.

In what I have now stated, I have alluded merely to the comparative effects produced by quantities of the different manures; but when we come to the question of actual economy, we get into a new complication. The difficulty which meets us is, that while guano and special manures generally have a fixed market price, the cost of farm-yard manure is purely conventional, and differs greatly in different districts. The only two of the speakers who have attempted to determine its price, are Mr Dickson and Mr Dudgeon; and the former estimates it, including the cost of application, at 8s.; the latter at 5s. per ton. The latter estimate is founded on the price at which dung can be bought in the neighbourhood; and though Mr Dickson does not state the grounds of his calculation, I presume it is similar. Now, I think the estimate ought to differ according to circumstances. Suppose a farmer finds that he is unable to produce upon his farm as much manure as he requires, ought he to make up the deficiency by purchasing guano or farm-yard manure? There can be no hesitation in deciding in favour of guano. For, on Mr Dudgeon's estimate, we must pay for 20 tons of manure £5, and on Mr Dickson's £8, while 4 cwt. of guano, which may be substituted for it, may be bought for £2. But the question is different if he can produce as much manure on the farm as he actually requires. He is not then entitled to estimate his farm-yard manure at the rate at which it may be purchased, but at the cost of production; and it is in estimating this that the great difficulty is experienced. In fact, a habit has crept into agriculture, which I think extremely objectionable, of estimating the value of the manure, by assuming that a certain fraction of the food of the cattle remains in it, and the cost of this part of the food is withdrawn from the expense of feeding the cattle, and taken as representing the cost of producing the manure. I must confess I have always been of opinion that there is no way in which a farmer is more likely to deceive himself; the proportion of the food which is thus to be referred to the manure-heap being mere guess-work, unsubstantiated by experiment, and generally over-rated; as, for instance, when we hear of one-third of the price of oilcake being debited to the manure. It would be much wiser to ascertain the expenses of feeding, irrespective of the manure-heap, and then, of course, if there is a profit upon it, the manure is got without cost, and nothing but the expense of application is to be estimated; if, on the other hand, there is a loss, that loss is the cost of production of the

manure, and it must be the object of the farmer to see that it does not exceed the price at which farm-yard or artificial manures can be purchased.

As far as the manure produced by auxiliary feeding goes, Mr Main pronounces against its economy, and calculates that in the experiment before alluded to, he lost 17s. 2d. per acre, although the produce of turnips was increased by 3 tons 9 cwt.; but his estimate is founded on the assumption that one-third of the cost of the oilcake must go to the manure, although he does not himself consider it fair. The proper plan would have been to have stated also the profit or loss upon the cattle; for if there was a profit equal to that upon those fed without oilcake, then, of course, there was a direct gain of 3 tons 9 cwt. of turnips, worth about £1, 5s. On the whole question, theory and practice concur as to the advantages of light manures; but they must be judiciously applied, and must be used only as auxiliaries, and not independently of farm-yard manure.

4. With the last discussion, that on flax culture, I shall not detain you very long; not that it is less important than those which have preceded it, but because it consists of statements which must be read in full to be appreciated, and which have, moreover, already appeared in a more extended form in the Transactions of the Society, and have been honoured by premiums. These statements are well deserving of attention, as they contain the most precise and satisfactory information we as yet possess regarding the recent cultivation of flax in Scotland. I need not inform you that, though once cultivated to some extent in Scotland, flax had been almost entirely abandoned until within the last few years, when the altered circumstances of agriculture again directed the attention of farmers to it, and induced the inquiry as to whether, with the low prices of grain, it might not again be profitably introduced into the rotation. This inquiry has obtained additional importance from the introduction of processes which, by replacing the old method of steeping the flax, have produced a market for it in the straw, and have relieved the farmer of a process very different from those to which he is accustomed, always attended with much trouble, and often with uncertainty and loss. It may, indeed, be safely laid down as a rule, that in a country where labour is dear and rents considerable, the old process can scarcely be made to pay, except under the most favourable circumstances. But we know very well that the process of retting as it used to be practised is extremely uncertain, and its success dependent upon the nature of the water, the uniformity of temperature and steadiness of weather, and upon various little precautions, inattention to which may deteriorate the fibre to such an extent, as to make it comparatively worthless. In short, if flax is to pay now, it must be with the assistance of these new

processes, and no farmer will act wisely who attempts its cultivation, except in localities where he has ready and cheap access to establishments in which they are performed.

The evidence brought forward at the meeting certainly went to prove that, where this can be managed, the profits derived from the flax surpass those of a crop of oats,—Mr Hodgson, on his first year's trial, having found an advantage of no less than £4, 5s. 8d. per acre in favour of the former; and though so great a difference was probably due to exceptional causes, and is not found in the subsequent year, there is still a very decided superiority on the side of the flax. It has always been urged as a great objection to flax, that it removes from the land a larger quantity of mineral matters than any other crop; but the chemical investigation of the plant shows that there has been much misapprehension on this point, and that under proper management it does not exceed, if indeed it does not considerably fall short of, other crops in this respect. It has been thoroughly established that, with flax as with other crops, the principal part of the valuable constituents are accumulated in the seed, and comparatively little in the straw. Now, it has been found by experience that the finest quality and most valuable fibre is obtained when the flax is cultivated under such circumstances, that its production of seed is as small as possible. This is effected practically by sowing close, and by avoiding too large a supply of manure, which has the effect of producing a coarse and inferior fibre. If this system be pursued—and it is manifestly that which for all reasons must be most profitable—flax cannot be considered more exhausting than a white crop. I am assuming, of course, that, as used formerly to be the case, both straw and seed are removed from the land; but if, as will probably henceforth be practised, the seed be employed for feeding on the farm, I apprehend it will turn out to remove less valuable matters than a crop of oats, of which the seed is removed, and the straw returned to the land. Such, at least, is the inference to which science would lead us, but it would be most desirable to have it confirmed by actual experiment; and the gentlemen who have gained the Society's premiums would do a further service to agriculture, if they would make public the results obtained from the subsequent crops, in the rotation in which their flax was grown. Mr Reid, indeed, has given us the result of a bean crop immediately following the flax, but with an application of 25 tons of farmyard manure, in which they surpassed those following oats by no less than £1, 18s. 4d.; but it would be unwise to draw general conclusions from a single experiment, and, for my own part, I do not anticipate that any difference will be found; but even if there were a slight difference in the opposite direction, I do not think that, in the advanced state of agriculture, the farmer ought to be deterred by it, or that there would be any deficiency

which might not be easily made up by a slightly more liberal treatment afterwards. An important advantage of flax is, that it appears to be best produced in soils of somewhat inferior quality; at least it is certain that too rich a soil is injurious, as, by promoting too luxuriant a growth, it produces a coarse fibre, and greatly diminishes its value. In fact, success appears to be best obtained on a soil which is not too rich, nor too dry, and which is reduced to a fine tilth, and is sufficiently deep.

The cultivation of flax has received a great impetus from the improved methods of steeping; and though the farmer ought henceforth to have nothing to do with that process, he must naturally feel interested in it, as every improvement must in the long-run tell to his advantage. The process now generally employed is that patented by Schenck, and it is extremely simple in principle. It consists in placing the flax straw in small vats, in which it is covered with water kept at a uniform temperature of 90 degrees, by a steam-pipe passing through it. The flax is exposed to this treatment for a period of from sixty to seventy hours, and, at the end of that time, the process of fermentation is complete, and the fibre can be separated from the husk and other parts. There is no question that this process is a great improvement, but I have no doubt that it is yet in its infancy, and that it is still far from perfect. I happen to know that a patent for steeping flax upon another plan is also about to be taken out, the preliminary experiments on which have, I am given to understand, been most successful. Other processes have also been proposed; and one—that of the Chevalier Claussen—has been introduced to the public with great flourish, and great results are expected from it, but which, I must confess, I do not think will be realised. That patent, as you are probably aware, is for a method of converting flax into a substance like cotton, which is done by a somewhat complicated process. Now, if the patent had been for converting cotton into flax, I should have understood it, for that would have been converting a cheap material into a dear one; but I cannot see how anything is to be made by converting a dear substance into a cheap one. If it is meant that inferior qualities of flax are to be converted into fine cotton, we can just conceive the possibility of its paying; but if that is all that is to be done, it can be of no benefit to the farmer, because he may depend upon this, that if he is to make the cultivation of flax pay, he must aim at producing only the superior qualities.

I have thus, gentlemen, endeavoured, as fully and fairly as I could, to bring under your notice the most important parts of these discussions. I fear that, in my desire to avoid prolixity, and to compress my address within reasonable limits, I may have omitted many points worthy of more extended notice, but I trust I have said enough to justify the statement with which I set out, that

these meetings were well deserving of public attention. Their peculiar interest is, that while they point out the present state of our knowledge, they indicate also those matters on which our information is still deficient, and are full of observations which serve to show where experiment is required to add to or elucidate it. I have endeavoured, to the best of my power, to bring these distinctly before you; and, though I am conscious of many deficiencies in the manner in which I have executed my task, I trust they may be excused. I might, perhaps, have selected a more entertaining subject, and with much greater ease to myself, but I conceived it would be best to occupy your time with something connected with the general business of the Society.

PROCEEDINGS IN THE LABORATORY.

By Thomas Anderson, M.D., Chemist to the Highland and Agricultural Society.

ON THE COMPOSITION AND COMPARATIVE VALUE OF DIFFERENT SORTS OF CLOVER.

The frequent failure of the red clover crop has of late years directed attention to the cultivation of other varieties of clover; and some of these have been introduced to a considerable extent, and probably would be still more largely cultivated, were it not for the difference of opinion which exists among practical men as to their comparative values. These differences of opinion were brought conspicuously before me by the observations made at one of the monthly meetings of the society, at which yellow clover was as strongly approved of by some as it was condemned by others; and the desire to ascertain which of these opinions was correct, or whether they did not admit of being reconciled, induced me to undertake comparative analyses of the two species, and at the same time to extend the investigation to several other varieties, a knowledge of the composition of which, I thought, might prove of interest to the farmer.

The clovers employed for analysis were raised from authentic specimens of seed, supplied by Messrs Lawson; and as the analyses were intended to be strictly comparative, it was thought best that they should be grown under precisely similar circumstances. They were, therefore, sown in small patches in a garden soil of fair quality, in Messrs Lawson's nursery; and this plan was adopted because it seemed likely to lead to more uniform results, and to exclude many sources of fallacy which could not fail to be introduced, if specimens had been collected from different fields, in which they might have been cultivated under very different circumstances. It may possibly be objected that the specimens thus obtained are in a condition very different from that in which they are raised in the field; but a very little consideration will be sufficient to show that this objection can scarcely be a valid one.

It would certainly be so, had my object been to compare the relative produce per acre of the different sorts, which would in all probability have led to results very different from those obtained in the field; but my aim being to determine merely the comparative abundance of valuable constituents, in equal weights, of the different plants, this difficulty disappears; for I have found, as a general rule, that though a superior soil produces a more luxuriant growth, and consequently a larger produce per acre of any crop, it does not materially, if at all, increase the quantity of valuable matters which a given quantity of the crop will contain.

The analyses embrace different varieties of red clover, (*Trifolium pratense*,) cow-grass, (*Trifolium medium*,) crimson clover, (*Trifolium incarnatum*,) yellow clover, (*Medicago lupulina*,) Alsike clover, (*Trifolium hybridum*.) They were intended to have included also white clover, but for some reason or other these were not grown at the same time. Of some of these species several different specimens were grown, as varieties exist which present well-marked differences in their habit of growth, and other peculiarities, which enable the practised eye to determine at once with considerable certainty the source from which the seed was obtained, and are very obvious to any one when they are pointed out. The selection of these samples was intrusted to Mr Lawson, whose experience enabled him to choose those which present the most marked differences, and are of the highest practical importance. The plants were collected as soon as they came into full power, which occurred with the crimson clover early in August, but with the others not till the middle of September.

The method of analysis consisted in determining the amount of water in the moist plant, which was done by weighing off a small quantity, carefully selected, so as to give a proper average, and drying it at the temperature of 212°, which required from eight to twelve days. The dry residue was then employed for the determination of the per-centage of ash and of nitrogen, and the quantity of these in the moist substance obtained by calculation. An attempt was also made to determine the quantity of oil, which proved to be excessively small; but the presence of Chlorophyle, the green colouring matter of plants, which cannot be separated from the oil, complicated the results so much that I was induced to abandon the attempt, which appeared to me likely to lead to fallacious results, the more especially as the quantity was so small as to be comparatively unimportant. The remainder of each sample was dried and burned in a platinum basin to yield the ash which was analysed in the usual manner. In detailing these analyses, I have given both the actual results of the experiment, and the numbers, calculated without the carbonic acid, the small variable amount of charcoal, which is always left unconsumed, however carefully the plant may have been burned, and the sand which cannot be separated from the plant before burning. The experi-

mental results are contained in the first,—the calculated in the second column of the analyses.

No. 1.—*Red Clover from English seed.*

Water,	85.30
Dry residue,	14.70
Ash in 100 parts of wet substance,	1.30
Nitrogen in do.,	0.37
Ash in 100 parts of dry substance,	8.90
Nitrogen in do.,	2.54

Analysis of ash.

	No. 1.	No. 2.
Silica,	1.82	2.39
Peroxide of iron,	1.18	1.54
Lime,	20.05	26.32
Magnesia,	7.88	10.34
Sulphuric acid,	2.75	3.63
Phosphoric acid,	3.81	5.01
Chloride of sodium,	5.44	8.45
Chloride of potassium,	8.45	11.08
Potash,	23.81	31.24
Sand,	6.92	
Charcoal,	0.24	
Carbonic acid,	16.79	
	100.15	100.00

No. 2.—*Red Clover from seed grown in the Rhine district of Germany.*

Water,	81.68
Dry residue,	18.32
Ash in 100 parts of wet substance,	1.49
Nitrogen in do.,	0.45
Ash in 100 parts of dry substance,	8.15
Nitrogen in do.,	2.48

Analysis of ash.

	No. 1.	No. 2.
Silica,	2.18	2.86
Peroxide of iron,	1.37	1.81
Lime,	19.75	25.98
Magnesia,	7.65	10.05
Sulphuric acid,	2.99	3.93
Phosphoric acid,	6.25	8.22
Chloride of sodium,	7.67	10.08
Chloride of potassium,	4.43	5.83
Potash,	23.76	31.23
Sand,	8.15	
Charcoal,	0.10	
Carbonic acid,	15.70	
	100.01	100.00

No. 3.—*Red Clover grown from seed from the North of France.*

Water,	83.51
Dry residue,	16.49
Ash in 100 parts of wet substance,	1.95
Nitrogen in do.,	0.36
Ash in 100 part of dry substance,	11.82
Nitrogen in do.,	2.17

Analysis of ash.

	No. 1.	No. 2.
Silica,	1.069	1.433
Peroxide of iron,	0.828	1.204
Lime,	25.569	34.286
Magnesia,	9.400	12.605
Sulphuric acid,	2.789	3.650
Phosphoric acid,	6.336	8.496
Chloride of sodium,	2.071	2.777
Chloride of potassium,	9.022	12.098
Potash,	17.488	23.451
Sand,	4.201	
Charcoal,	0.434	
Carbonic acid,	21.030	
	100.237	100.000

No. 4.—*Red Clover grown from American seed.*

Water,	79.98
Dry residue,	21.02
Ash in 100 parts of wet substance,	1.58
Nitrogen in do.,	0.46
Ash in 100 parts of dry substance,	8.05

Analysis of ash.

	No. 1.	No. 2.
Silica,	2.03	2.673
Peroxide of iron,	1.17	1.413
Lime,	20.24	26.753
Magnesia,	6.80	8.974
Sulphuric acid,	2.66	3.502
Phosphoric acid,	3.06	4.030
Chloride of sodium,	3.50	4.621
Chloride of potassium,	14.38	18.944
Potash,	22.09	29.090
Sand,	8.02	
Charcoal,	0.03	
Carbonic acid,	15.66	
	99.64	100.000

No. 5.—*Red Clover from Dutch seed.*

Owing to an accident, the determination of the water in this specimen was lost; I am therefore only able to give the results on the dry substance.

Ash in dry substance,	8.82
Nitrogen in do.,	1.99

Analysis of ash.

	No. 1.	No. 2.
Silica,	0.971	1.313
Peroxide of iron,	1.099	1.470
Lime,	25.810	34.908
Magnesia,	9.003	12.176
Sulphuric acid,	2.749	3.718
Phosphoric acid,	5.426	7.352
Chloride of sodium,	8.204	11.096
Potash,	18.427	24.928
Soda,	2.247	3.039
Sand,	5.029	
Charcoal,	0.723	
Carbonic acid,	20.084	
	99.972	100.000

A comparison of these analyses indicates a considerable difference in the nutritive value of the different samples. This is particularly seen when we compare the proportions of solid matters and of nitrogen they contain, which may be considered as affording a pretty fair criterion of their value as food; the former indicating the total amount of all the nutritive matters present; the latter giving, of course, the quantity of nitrogenous matters, which are by much the most important—so much so, indeed, that some distinguished chemists have even conceived that the other constituents may be neglected in determining the relative nutritive values of different substances. If we exclude No. 5—which, from the non-determination of the proportion of water, does not admit of being compared in this way with the others—we find Nos. 2 and 4 nearly equal in value, and decidedly superior to the other two, and the difference is most marked between No. 1 and No. 4. While the former of these contains only 14.70 per cent of solid matters, the latter contains 21.02, or nearly half as much again. A similar, though not quite so great a difference exists between the amounts of nitrogen, which are in the proportion of 0.37 to 0.45, or nearly as 4 to 5. It is interesting, however, to observe that this difference holds good only between the moist plants, and that the proportion is reversed if we compare the substances in the dry state; for 100 parts of the dry substance of No. I. contain 2.54 per cent of nitrogen, and of No. 4, only 2.35. An important practical inference is to be deduced from this fact; for it is manifest that the choice which is to be made between them must depend upon the state in which they are compared. I shall best make this intelligible by supposing that a farmer had it in view to purchase a certain quantity of *clover grass* and of *clover hay*—suppose 100 tons of each. Then, in the former case, he would obviously select No. 4; because in his 100 tons of the fresh clover he would obtain in No. 4 nearly half a ton of nitrogen, and in No. 1 little more than one-third; while, if he were to purchase the hay, he would choose No. 1, because the difference would be in its favour. What the precise difference would be can-

not be exactly stated, because the analysis was made upon the absolutely dry substance, while hay, though we call it dry in ordinary language, still contains several per cent of moisture. I have assumed, also, the existence of a hay containing nothing but red clover, which is practically never produced in Scotland; but it will be understood that this is done merely to bring distinctly out the fact that the relative values of two substances may be different, according as they are compared in the dry or the moist state. A comparison of the analyses of the ashes yielded by the different samples also shows considerable differences, which particularly affect the proportion of lime and of chlorine, potash and phosphoric acid. These differences will be made apparent by the following table, containing the proportions of these substances, arranged so that they may be easily compared.

	1.	2.	3.	4.	5.
Lime, . . .	26.32	25.98	34.28	26.75	34.90
Sulphuric acid, .	3.63	3.93	3.65	3.50	3.71
Phosphoric acid, .	5.01	8.22	8.49	4.03	5.42
Chloride of potassium,	11.08	5.83	12.09	18.94	
Potash, . . .	31.24	31.24	23.45	29.09	24.92

Two of the specimens contain a quantity of lime greatly larger than the others; but, what is interesting, this is unaccompanied by any increase in the sulphuric acid, which has been often supposed to vary with the lime, with which it is considered to be in combination. The variations in the phosphoric acid and potash are also extremely large—those of the latter especially, when we bear in mind that we must compare the total quantities of potash —of which part exists as potash, and part as chloride of potassium— in all, excepting the last, (No. 5,) in which none of the latter compound is found.

I think it necessary to observe that, while these analyses indicate great differences between different samples of red clover, it must not be supposed that they establish the superiority of one or other variety. To do so, an extended series of analyses of specimens of each will be required, as it is necessary to found, not upon one, but upon the average of several analyses. I may observe, in passing, that it would be of much importance to determine how much of the nutritive value of the different samples may be dependent upon the constituents of the ash; if, which is probable, only a small part of it be so, then we ought by preference to select those samples which take up the smallest proportions of the rarer and more valuable constituents of our soils. Thus, for instance, we should select No. 4 in preference to No. 2, because, though the total quantity of inorganic constituents which each will remove from the soil will be nearly equal, the amount of phosphoric acid in No. 2 will be more than double that in No. 4.

Two specimens of cow-grass (*Trifolium medium*) have been

analysed, both from English seed; the first considered to be very fine, the second an ordinary quality.

No. 6.—*Cow-Grass, Duke of Norfolk.*

Water,	77.39
Dry residue,	22.61
Ash in 100 parts of wet substance,	2.73
Nitrogen in ditto,	0.36
Ash in 100 parts of dry substance,	12.09
Nitrogen in ditto,	1.63

Analysis of Ash.

	No. 1.	No. 2.
Silica,	1.295	1.681
Peroxide of iron,	1.129	1.600
Lime,	20.692	26 872
Magnesia,	15.388	19.855
Sulphuric acid,	3.280	4.259
Phosphoric acid,	4.967	6.450
Chloride of potassium,	12.258	15.923
Potash,	17.987	23.360
Sand,	3.527	
Charcoal,	0.255	
Carbonic acid,	19.642	
	100.420	100.000

No. 7.—*Cow-Grass, Ordinary.*

Water,	81.76
Dry residue,	18.24
Ash in 100 parts of wet substance,	1.92
Nitrogen in ditto,	0.51
Ash in 100 parts of dry substance,	10·53
Nitrogen in ditto,	2.30

Analysis of Ash.

	No. 1.	No. 2.
Silica,	1.080	1.402
Peroxide of iron,	0.983	1.293
Lime,	23.586	30.251
Magnesia,	8.362	10.857
Sulphuric acid,	2.568	3.334
Phosphoric acid,	4.773	6.197
Chloride of sodium,	1.803	2.341
Chloride of potassium,	11.959	15.514
Potash,	21.981	28.541
Sand,	3.578	
Charcoal,	0.185	
Carbonic acid,	19.459	
	100.177	100.090

A general resemblance in the analytical results may be observed between these and the red clovers, in all the constituents. No. 7, however, from the larger proportion of nitrogen which it contains, must exceed them all in nutritive value. The other specimen—that which is considered a very fine variety—curiously enough is decidedly inferior, and stands on a level with the lower quality of red clover. I have not been informed as to the cause of its

reputed superiority, but it may be owing to its producing a more bulky crop, which may more than make up for the deficiency of quality.

The next two analyses are of samples of yellow clover, the one from English, the other from French seed.

No. 8.—Yellow Clover, raised from English seed.

Water,	77.38
Dry residue,	22.62
Ash in 100 parts of wet substance,	2.02
Nitrogen in do.,	0.56
Ash in 100 parts of dry substance,	8.95
Nitrogen,	2.47

Analysis of Ash.

	No. 1.	No. 2.
Silica,	1.64	2.07
Peroxide of iron,	1.30	1.64
Lime,	16.00	20.14
Magnesia,	7.78	9.80
Sulphuric acid,	4.00	5.03
Phosphoric acid,	4.48	5.64
Chloride of sodium,	7.57	9.53
Chloride of potassium,	10.86	13.67
Potash,	25.80	32.48
Sand,	6.34	
Charcoal,	0.48	
Carbonic acid,	13.23	
	99.48	100.00

No. 9.—Yellow Clover, raised from French seed.

Water,	78.60
Dry residue,	21.40
Ash in 100 parts of wet substance,	1.75
Nitrogen in do.,	0.47
Ash in 100 parts of dry substance,	8.18
Nitrogen in do.,	2.19

Analysis of Ash.

	No. 1.	No. 2.
Silica,	1.01	1.24
Peroxide of iron,	0 86	1.05
Lime,	18.61	22.80
Magnesia,	8.34	10.22
Sulphuric acid,	4.42	5.42
Phosphoric acid,	7.15	8.77
Chloride of sodium,	5.98	7.32
Chloride of potassium,	11.98	14.68
Potash,	23.26	28.50
Sand,	2.87	
Charcoal,	0.72	
Carbonic acid,	14.79	
	100.00	100.00

I mentioned in the outset that some persons considered yellow clover to be of little or no nutritive value, but these analyses show that this opinion must be ill-founded, for a comparison of the analyses leads us to the conclusion that it must be of at least equal value to red clover. In fact, the percentage of nitrogen in

both is greater than in red clover, and the amount of solid matters is fully as large as is found even in the best samples of that plant. In the constituents of the ash there is the same general resemblance to red clover which has been already remarked in the case of cow-grass, the only striking difference being in the smaller proportion of lime which the yellow clover contains.

From particular circumstances it was found impossible to make a complete analysis of the ash of the *Trifolium incarnatum*, but the determination of the amount of water, nitrogen, and ash, was made.

No. 10.—*Trifolium Incarnatum, from French seed.*

Water,	82.56
Dry residue,	17.44
Ash in 100 parts of wet substance,	1.88
Nitrogen in do.,	0.52
Ash in 100 parts of dry substance,	10.81
Nitrogen in do.,	2.97

It would appear from this that the crimson clover is a very valuable species, and surpasses any of the other specimens analysed, the amount of nitrogen being higher than any obtained from the other plants, and considerably above the average of the whole.

The last analysis was that of a single specimen of Lucerne, of which the results are given below.

No. 11.—*Lucerne.*

Water,	80.13
Dry residue,	19.87
Ash in 100 parts of wet substance,	2.49
Nitrogen in do.,	0.49
Ash in 100 parts of dry substance,	11.77
Nitrogen in do.,	2.48

Analysis of Ash.

	No. 1.	No. 2.
Silica,	2.34	3.18
Peroxide of iron,	1.98	2.68
Lime,	18.31	24.79
Magnesia,	4.64	6.28
Sulphuric acid,	4.27	5.79
Phosphoric acid,	5.75	7.80
Chloride of sodium,	1.70	2.30
Chloride of potassium,	10.35	14.02
Potash,	24.49	33.16
Sand,	10.62	
Charcoal,	0.35	
Carbonic acid,	15.02	
	99.83	100.00

It is unnecessary for me to dilate on the results which these analyses present, as the observations already made are sufficient to indicate the comparative values of the different substances. I shall take another opportunity of comparing them with the other sorts of cattle food, and shall then enter more fully on the subject of the principles upon which the nutritive value of these substances may be most satisfactorily estimated.

ANALYSES OF THE ASH OF THREE SPECIES OF SEA-WEEDS.
BY MR JOHN YEATS.

The following analyses were made, during the past spring, on specimens of the weeds collected in the Firth of Forth. The analyses were conducted in the method usually employed for the analysis of ashes, and do not call for any remarks, except as to the mode of burning, and separation of iodine from the other constituents. The weeds, as soon as collected, were carefully examined, and all small shells and foreign matters picked off, after which they were washed with a small quantity of fresh water, and dried with a cloth, so as to remove as much as possible of the sea water by which they were moistened. They were then cut into small pieces, and dried by exposure to a temperature somewhat above 212°; and, when thoroughly dry, were incinerated in a large platinum basin. In doing this some difficulty was experienced, as, from the fusibility of the ash, it was very liable to melt and protect the carbonaceous matters from combustion, by forming a coating over them. By carefully keeping the heat very low, it was found possible to avoid this to some extent, and to get rid of the greater proportion of carbonaceous matters, but never to produce a white ash. Some benefit was gained by this necessity for employing a very low temperature; for, as the iodine salts, the accurate determination of which formed my special object, are very volatile at high temperatures, a certain proportion of them would almost inevitably be lost, if the plants were burned at such temperatures as may be safely employed in other instances. The determination of iodine was effected in the usual manner, by means of chloride of palladium. The *Fucus serratus* was taken from the low rocks beyond the quarry at Granton. The *Fucus nodosus* came from the coast near Burntisland, and was a remarkably large and fine specimen. The *Laminaria digitata* was taken from the Black Rocks, off Leith, at the very lowest spring tides. Great quantities of the weed grow in that locality, but are seldom accessible, owing to the depth of the water. The first column contains the actual results of analysis—the second, the results calculated without the sand, charcoal, and carbonic acid.

Laminaria Digitata.	1.	2.
Potash,	28.81	31.812
Chloride of potassium,	17.84	19.764
Iodide of potassium,	1.20	1.365
Chloride of sodium,	21.69	23.986
Lime,	5.01	5.351
Magnesia,	3.11	3.454
Peroxide of iron,	1.18	1.333
Sulphuric acid,	8.69	9.598
Phosphoric acid,	2.98	3.297
Silica,	0.03	0.050
Carbonic acid,	4.23	
Sand,	1.69	
Charcoal,	3.36	
	99.82	100.000

Fucus Serratus.	1.	2.
Potash,	28.11	30.870
Chloride of sodium,	5.60	6.148
Soda,	23.55	25.859
Lime,	7.22	7.927
Magnesia,	5.80	6.368
Peroxide of iron,	0.21	0.230
Sulphuric acid,	16.28	17.870
Phosphoric acid,	2.26	2.480
Silica,	2.04	2.246
Carbonic acid,	4.57	
Sand,	0.88	
Charcoal,	2.78	
	99.30	100.000

Fucus Nodosus.	1.	2.
Potash,	12.10	13.320
Chloride of potassium,	25.12	29.885
Chloride of sodium,	13.08	15.557
Lime,	6.43	7.647
Magnesia,	4.70	5.636
Peroxide of iron,	0.10	0.135
Sulphuric acid,	20.85	24.812
Phosphoric acid,	0.71	0.848
Silica,	0.97	1.160
Carbonic acid,	2.13	
Sand,	0.64	
Charcoal,	13.30	
	100.13	100.000

OBSERVATIONS ON THE POSSIBILITY OF IMPROVING THE QUALITY OF KELP. BY DR ANDERSON.

The foregoing analyses were intended to form part of an extended investigation which I proposed making, and which had for its object the determination of the economic value of sea-weeds, both as a manure and a source of kelp. For the purpose of arriving at satisfactory conclusions on these points, I intended to accumulate analyses, not merely of the ash, but also to determine the amount of nitrogen which the plants contain in the moist state, and such other facts as seemed necessary to define their manurial value. Want of opportunities for collecting sea-weeds at different localities and seasons, and occupation with other matters, of perhaps more general interest to the agricultural public, have hitherto prevented the active prosecution of the subject, and may delay its completion for some time. In the mean time, the following observations may not be unacceptable to those more immediately connected with the districts in which kelp is produced, as its improvement might be of some importance, and form a valuable means of giving increased employment to the poverty-stricken inhabitants of the Western Islands, as well as a source of improvement to their agriculture.

It is familiarly known to every one connected with the Highlands, that the price of kelp has of late years undergone a great change; and that, while during the war, £10, or even £20 per ton

were current prices, £2 or £3, and, in some instances even less, are all that can now be obtained for it; while that variety which is obtained from sea-weeds which are purposely cut, and is commercially known as cut-weed kelp, is almost entirely unsaleable. It is worth while to point out the causes of this remarkable depression. Thirty or forty years ago, kelp was one of the great sources of carbonate of soda—one of the most important raw materials of the chemical arts; and from it and barilla, which name is applied to the ash of the sea-weeds growing on the coast of Spain, nearly the whole of the soda employed in the arts was obtained. Barilla is a much more valuable source of carbonate of soda, and contains it in much larger quantity than kelp—the former yielding about 20 per cent of soda, the latter not more than from 2 to 4 per cent. Notwithstanding this difference, however, the high price of barilla always occasioned a considerable demand for kelp; but the circumstances connected with the war led to the rapid rise in its price and extension of its manufacture. Barilla, always expensive, and difficult to be obtained in quantity adequate to the demand for it, became entirely inaccessible to the manufacturer; and kelp, at that time the only other source of soda, underwent a proportionate rise in value; and the consequent increase in the price of soda was severely felt, and, for the time, almost annihilated some branches of manufacture. The difficulties which were felt here were equally experienced in France; but while, in this country, they were passively borne, without any attempt being made, either by themselves or the government, to relieve the manufacturers, a very different result followed in France; and Napoleon, impressed with the importance of cheap soda to the manufacturing industry of France, offered a reward of a million francs, or nearly £40,000, for a successful process for converting common salt into carbonate of soda. Several different processes were proposed, but one contrived by a chemist of the name of Leblanc, proved greatly superior to all the others, and fulfilled, in all respects, the proposed conditions. The process was soon adopted in France, and passed over into this country, and, with some modifications in detail, is still employed in all our manufactories; and though various other processes have since been patented, none of them have succeeded in displacing it. The consequence of the introduction of this process was an immediate fall in the price of soda; and as its practical working became better understood, and various improvements in the management of the details were introduced, a gradual and steady diminution in its cost has gone on ever since; and it is now sold at a price at which it could not be extracted from kelp, even if the manufacturer obtained that substance for nothing. In fact, kelp would at the present moment have been an utterly worthless article, had it not been for another chemical discovery, which, almost at the time that soda ceased to be extracted from it, con-

ferred a new value upon it. The discovery of iodine in the ashes of sea-weeds, and its value as a medicinal agent, has supported the kelp manufacture in a languid state for the last twenty years; but, from the small price which the iodine manufacturers are able to pay for it, as it is at present produced, there is no great encouragement to attempt increasing its production. It has, however, often struck me, that it might be possible to produce some improvement in this respect, which might be worthy the attention of some of our Highland proprietors.

The manufacture of kelp is carried on in the Islands of Scotland in the rudest and most primitive manner possible, and little or no attempt has been made to improve it. The process is conducted in just the same manner as it was when kelp was employed as a source of soda, and when that substance was attended to, and no thought taken of the other constituents. Now, however, things are completely changed—the soda is almost worthless; and though it is still extracted by the manufacturer, he does it merely because his doing so is a necessary step to obtaining the iodine, which is the substance from which he derives his profit. It is obvious that the manufacturer must now value a specimen of kelp for the iodine, and not for the soda, which it contains; and that, if the price of kelp is to be raised, it must be by producing it under the circumstances which are most favourable to obtaining a large percentage of iodine. Comparatively little attention has as yet been paid to this matter, and the old mode of manufacture is still adhered to—a method which, though favourable enough to the production of soda, is the very reverse as far as iodine is concerned, and requires to be entirely altered when it is sought to be obtained in larger quantity. In some places attempts have been made to modify the process, so as to obtain a kelp more suited to the iodine manufacturer, and with partial success; but the whole subject is still in its infancy, and deserves a more careful examination than it has yet received. In addition to iodine, a considerable quantity of chloride of potassium is now also extracted from kelp, and some part of its value is dependent upon that substance. But while it is possible, and indeed probable, that, by care and attention, the quantity of iodine may be considerably increased, it is improbable that any material difference can be produced in the quantity of the chloride of potassium.

The proportion of iodine which a specimen of kelp contains varies excessively, and depends partly on the weeds employed for making, and partly on the manner of burning. The analyses which are given in the previous notice indicate how much is dependent upon the former of these points; for while two specimens of kelp (made respectively from the *Fucus nodosus*, and *Laminaria digitata*) might be equally pure and carefully prepared, the one would be valuable, the other worthless. One of the

objects which I had intended to have examined more fully than it has yet been done, is the percentage of iodine in the ash of the different species of weeds; for though we have a considerable number of analyses at present, they are not as varied as might be desired, and none of them have been made with weeds collected in localities where the manufacture of kelp is actually pursued. It is uncertain, moreover, whether the determinations of iodine are all of them accurate; and, at all events, the differences are so great, as to render it desirable to repeat them with care. One thing appears, however, to be distinctly made out, and it is that the amount of iodine is largest in the different species of *Laminaria*, or what in Scotland is commonly called "tangle." Mr Yeats' analyses, while they indicate the entire absence of iodine in the *Fucus nodosus*, and the existence of traces only in *Fucus serratus*, show that the ash of *Laminaria digitata* contains 0.91 per cent of pure iodine, or upwards of twenty pounds in the ton. Other observers have found a much larger proportion; and Gödechens, who examined the same plant from the mouth of the Clyde, found its ash to contain 3.04 per cent of iodine, or upwards of sixty-six pounds in the ton; while from the *Laminaria saccharina* he obtained 3.9 per cent, or about eighty-seven pounds per ton. He obtained also a small quantity of iodine from *Fucus nodosus*, in which, as obtained from this coast, no traces could be distinguished, even by the most delicate re-agents. It is manifest, then, that the quality of a kelp must be to a great extent dependent on the plants which have been selected for its preparation; and that when, as has been too commonly the case, everything that the sea throws up is indiscriminately employed, a kelp must be obtained very inferior to that which might have been produced by a rough process of selection, in which all those weeds which yield little or no iodine are rejected, and those only employed which are rich in iodine. On the other hand, something depends also on the state in which the plants are collected, as is obvious from the different results obtained by Messrs Yeats and Gödechens—the latter obtaining more than three times as much iodine from the same plant as the former. The following series of analyses of another weed, *Fucus vesiculosus*, by different chemists, may serve to render this difference still more conspicuous:—

	Clyde.	Mersey.	North Sea.	Denmark.	Greenland.
Potash, ...	15.23	...	17.68	9.03	17.86
Soda, ...	11.16	15.10	5.78	7.78	21.43
Lime, ...	8.15	16.77	4.71	21.65	3.31
Magnesia, ...	7.16	15.19	6.89	10.96	7.44
Chloride of sodium, . . .	25.10	9.89	35.38	3.53	25.93
Iodide of sodium, ...	0.37	...	0.13	...	...
Phosphates of iron and lime,	2.99	...	5.44	9.67	10.09
Peroxide of iron, ...	0.33	4.42	...	...	...
Sulphuric acid, ...	28.15	30.94	23.71	26.34	13.94
Silica, ...	1.35	7.69	.0.28	11.04	...
	100.00	100.00	100.00	100.00	100.00

Here two out of five contain iodine, and that in very small quantity, while in the others not the slightest trace of it is found. The conditions under which these differences occur have not been determined, but it appears probable that it may be dependent upon the degree of maturity of the plant. It is well known that, as far as land plants are concerned, their constitution is greatly different at different stages of their growth, and it is reasonable to suppose that the same may be the case with sea plants. No information is given by the analysts as to the period of the year at which their plants were obtained; but Mr Yeats collected his in early spring, and they were probably young plants, though they were as large as are usually found. However this may be, it appears desirable to make analyses at different seasons, for the purpose of establishing or refuting the idea of a difference in composition, and this I intended making part of my investigation. It is manifest that, whatever may be the changes which the weeds undergo at different seasons, the different species of *Laminaria* are always richest in iodine, and ought to be those selected for the manufacture of kelp. It may probably be urged that the separation of species would be attended with too great trouble and expense to make it practically available, and complete separation would certainly be so; but all that would be required would be the rejection of great masses of weeds containing only a small proportion of the species rich in iodine, and the selection of such as contained abundance of them. This might be effected without much labour, and the result would be the production of a better article.

Supposing a good supply of weeds to be selected, and properly dried, the next process is the burning, which requires to be effected with peculiar precautions, if the iodine is to be obtained in large quantity. The method commonly adopted is to burn it in hollow troughs, made of a few stones roughly put together, and from four to six feet long and broad, on which a fire is made, and the dry weeds are thrown on in suc-

cessive quantities until the supply is exhausted, or the trough becomes too full of the ash. In managing this process, the heat was urged as high as possible, so that the ash became white, as it thus obtained a higher price when brought to the market as a source of soda. So long as it was employed merely for the soda which it contained, this was a reasonable practice, and probably yielded a product richer in that substance than if it had been prepared at a lower temperature. But the circumstances most adapted for producing a good soda kelp are exactly those most injurious to an iodine-kelp. The iodides which are present in the sea-weeds have a certain degree of volatility at a red heat; and when the temperature is kept high for a long time during the incineration, a great part of that which the weeds contain is volatilised and lost. The extent to which this takes place during the preparation of kelp is unknown, and is probably dependent on a variety of circumstances occurring during the combustion; but we know well that, in the laboratory, when iodide of potassium or sodium is heated in a crucible, it volatilises to an appreciable, and when a current of air is allowed to pass over it, to a very decided extent. The latter is most nearly analogous to the conditions under which sea-weeds are burnt at present; so that there can be little doubt that the loss from this cause must frequently be considerable. That it can be diminished to a great degree by a very simple modification of the present process is undoubted. In fact, all that is necessary is to carry on the combustion of the weeds at as low a temperature as possible, and in smaller quantities at a time, than was formerly practised; and, instead of endeavouring to obtain a pale coloured kelp, to consider this as rather an indication that the proper temperature has been exceeded, and that some loss of iodine has taken place.

It may be worth pointing out the great inferiority of the kelp now in the market, to what might be produced if proper attention were paid to the points to which I have referred. If kelp were made entirely from *Laminaria digitata*, it ought, according to the analysis of Mr Yeats, to yield 20 lb. of iodine per ton; while, if that of Gödechens be taken to represent the true composition of the plant, as grown in the Western Islands, it ought to yield between 60 and 70 lb. per ton. In actual practice, however, I believe that from 6 to 12 lb. of iodine is the quantity usually extracted from a ton of kelp; and it need scarcely be observed, that the manufacturer obtains almost the whole of the iodine the kelp contains, for the method of separation is well understood, and the profit or loss of the manufacturer depending upon very small differences, every attention is paid to obtaining, as nearly as possible, the whole of the iodine which the kelp contains.

It is on this remarkable difference between the results of analysis of the ash of sea-weeds and of the commercial kelp, that I found

the opinion that it may be possible to improve the quality of kelp to such an extent as to raise its price, not certainly to that which it once commanded, but to such an extent as to make it more deserving the attention of Highland proprietors than it has of late years appeared to be. It is at least obvious, that if the manufacturer can afford to pay from £2 to £3 for kelp yielding only from 6 to 12 lb. of iodine, he would be able to afford a much higher price if he could obtain it with 20, 30, or 40 lb. per ton. Both he and the kelp-maker would be benefited by such a change; for the extraction of iodine from a rich kelp is easier and less expensive than from a poor one; and, while he could thus afford to give the high price, the kelp-maker would be saved the labour of burning, and the cost of sending to market a large quantity of rubbish, which adds to the bulk, without increasing the value of the kelp.

It appears to me that a decided benefit would be derived from careful selection and careful burning of the kelp, and that if the conditions under which its quality is likely to be highest were clearly explained to the persons employed in making it, and a price paid to them for it proportionate to the amount of iodine which it contains, a stimulus would be given to the production of a superior article, and that, by exciting emulation among the workmen, much good might be done.

I am far, however, from supposing that these recommendations exhaust all that might be done for the production of kelp. It is probable that methods of manufacture greatly superior to those now in use, and more suited to the present condition of the chemical arts, might be introduced. But it is doubtful whether these could be successfully carried out by the population of the Islands, who are scarcely competent to operations which require skilled labour. Were it possible to do so, it is probable that part of the extraction of the iodine might be profitably carried on at the place where the kelp is made, and furnaces might be employed for its combustion, the heat of which would serve for the evaporation of some of the liquors. It can scarcely be expected, however, that, in the present state of the Western Islands, the necessary capital should be forthcoming for such operations, the more especially as they would at first be of the nature of experiments, which might possibly fail, although, if judiciously and prudently conducted, I cannot help thinking they might have beneficial results.

A process of a very different nature for extracting iodine from sea-weeds, was suggested some years since by Dr Kemp, which was founded on a number of experiments which he made in the Isle of Man. He found that, if a quantity of sea-weeds be placed in a vat or large cask, with a spigot-hole at the bottom, they soon undergo fermentation, and a liquid runs off, which at first is sea-water, but after a time is the juice of the plants, containing the whole, or at least a great part, of their iodine. To this fluid he

proposed to add a small quantity of chlorine and starch, when the iodine is thrown down in the form of an insoluble compound with the starch, which was to be collected and sent into the market as a source of iodine, while the refuse was to be employed as a manure. This process, though ingenious, is too purely chemical for the localities in which it would have to be carried out, and involves the use of very large vessels, which could not be constructed without some expense. I have given it as an illustration of a number of processes which are not sufficiently simple for the purpose, the social condition of the inhabitants of the localities in which kelp is produced requiring that any process entrusted to them shall be of the very simplest kind. But there can be little doubt that some improvements might be effected; and a full inquiry into the whole conditions of the kelp manufacture, both on the large scale, and chemically, might be of much value. Meanwhile a certain benefit would most assuredly be derived for carefully attending to those circumstances to which I have already referred.

ON THE NUTRITIVE VALUE OF THE DIFFERENT SUBSTANCES EMPLOYED AS FOOD FOR CATTLE.

In no department of agriculture has a greater and more rapid improvement taken place than in all that relates to the feeding of stock. Instead of being confined, for the most part, to suburban farms in the immediate neighbourhood of markets, the development of the turnip crop and the facilities of carriage for the cattle have extended it over all parts of the country, and have made it, if not an essential, at least a very important part of farming operations. Of late years its importance has been still further increased by the low price of grain, which has induced the farmer to rely for some part of his annual profit on the result of his feeding, in place of expecting it entirely, or almost entirely, from his white crops, as used formerly to be the case. The consequence of this has been, that much greater attention has been paid to the circumstances most likely to insure success, and important changes have been introduced in almost every point relating to the management of fattening stock. Some of these improvements have been suggested by experience, but no small part of them have had their origin in the applications of science, which has been brought to bear with peculiar advantage upon this department of agriculture. There is, indeed, scarcely any subject in which the benefits of science are more distinctly seen; and simply because there is no scientific subject, directly bearing upon agriculture, which has been so carefully studied, or is so well understood. The nutrition of the animal body is one of the most important and interesting departments of

physiology, and has engaged the attention of a large number of the most distinguished cultivators of the science; and, though extremely complex, and abounding in questions still far from being satisfactorily answered, it has been more thoroughly studied, and its principles better established, than most of the other portions of that science.

The effects of a knowledge of these principles, imperfect as they still are, is seen in all the more skilfully managed farms of the present day, which have their feeding-houses built, and the dieting of the cattle carried on, in a manner strictly concordant with the suggestions of science. It has also pointed out the principles on which the choice of foods is to be made, and their comparative value estimated, and some progress has even been made in the determination of their values. Our information on these points is, however, still limited; for though much has been done by Boussingault and others, they have confined their inquiries too exclusively to one element of the food—the nitrogen, which, though no doubt the most important, ought not to be the only one considered.

Ever since I became connected with the Highland and Agricultural Society, the investigation of the nutritive values of different sorts of food has engaged much of my attention; and one of the objects which I set before me was, by an extended and careful series of analyses, to fix them in a satisfactory manner. In doing so, I proposed to take up the different substances one by one; and, by making analyses of each, grown under all possible circumstances of climate, soil, and manure, to determine the limits within which its value might oscillate. The investigation of the turnip, which appeared in a late number of the *Transactions*, is an individual instance of what I intended to do for all the others. It is manifest, however, that the completion of such a plan, and the performance of an equally elaborate series of analyses of each substance, must occupy a considerable time, and defer the possibility of making a comparison to a period which could not be easily fixed, and during which a great part of the analyses must be comparatively useless. I therefore resolved, in place of concentrating my attention on one substance, to accumulate one or two analyses of each substance, which might be published in the mean time, and which might serve at least as approximative estimates, which might be afterwards made more exact, by increasing the number of analyses, and obtaining the mean of all.

In conducting these analyses, I determined to adhere to the plan adopted with the turnips, both for the sake of uniformity, and because experience had shown me that, in a more extended analysis, the minuteness of detail is not at all commensurate to the increased labour; and that by making thorough analyses of their ashes, which I at one time intended, I should only accumulate a

mass of details which, in the present state of science, could not be made available for practical purposes. It will be unnecessary for me to refer here to the method of analysis, which is exactly that detailed in my paper on the comparative values of turnips grown in different localities, and under different circumstances, where everything relating to it has been already mentioned. In the arrangement of the analyses I shall proceed upon the principle of taking those first which contain the largest quantities of nitrogen and oil.

LINSEED CAKE AND LINSEED.

I had just commenced a series of analyses of linseed cake, intended to be as extensive as possible, and to embrace the sorts obtained from different localities, when Mr Way's paper on the same subject appeared in the Transactions of the English Agricultural Society; and as it embraced almost all that I intended to examine, I at once abandoned the further prosecution of the subject, as the analyses it contained were more than sufficient to determine the average value of different samples. In one point only were my analyses more complete than Mr Way's—namely, in the determination of the proportions of earthy phosphates and phosphoric acid; and I shall therefore give here a few such analyses, both to show the general concordance with his results, and to give the amount of phosphates which I have invariably determined in all the other substances analysed. They are selected from those which have been at different times sent to the Laboratory, and the exact localities from which they came are, with one exception, unknown; but it is believed that they are mostly from the North German and Baltic ports, which principally supply this market.*

	1.	2.	3.	4.	5.	6. Wolgast.	Average.
Water, .	12.00	11.72	13.52	15.55	10.21	11.65	12.44
Oil, . .	11.93	10.94	11.84	11.49	14.28	16.25	12.79
Nitrogen, .	4.45	4.26	4.45	4.54	4.48	3.83	4.33
Ash, . .	5.36	6.86	5.23	...	6.69	6.54	6.13
The ash contained—							
Sand, . .	0.80	2.24	0.67	1.04	0.52	...	1.05
Phosphates, .	2.38	2.78	2.37	2.68	3.23	2.95	2.73
Phosporic acid,	...	...	0.59	0.33	0.89	0.39	0.55

* Flensburg is one of the places from which large quantities come to Leith; and I believe several of the specimens were from that port.

(*To be continued.*)

Prospectus.

THE SECOND ISSUE

OF

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Edinburgh, *Sept.* 27, 1852.

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All Communications should be forwarded a month before publication of the Number in which it is desired they shall appear.

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